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of Engineers  
Seattle District

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# FLOOD SUMMARY REPORT NOOKSACK, SKAGIT AND SNOHOMISH RIVER BASINS NOVEMBER 1990 EVENTS



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                  | Floods, 1990 Skagit River, Washington                                             |                                      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                  | Nooksack River, Washington Snohomish River, Washington                            |                                      |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)<br><br>This report documents the flooding and related flood data of the two successive rain flood events in Western Washington that occurred during November 9-12 and 21-26, 1990. The report is organized in four primary categories: meteorology, hydrology, flood damages, and flood fighting. Included are newspaper articles giving the local viewpoint on both flood events. |                                                  |                                                                                   |                                      |
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1. Purpose. The purpose of this report is to document the flooding and related flood data of the two successive rain flood events in western Washington that occurred during November 9-12 and 21-26, 1990 for the Nooksack, Skagit, and Snohomish River basins. Although high water and flooding occurred in other basins, the scope of this report has been limited to the three river basins stated above.

2. Introduction. This flood report is organized under four primary categories: meteorology, hydrology, flood damages, and flood fighting. The meteorology portion covers the atmospheric characteristics of the storm as it passed over the basin, while the hydrology covers the characteristics of the runoff across the basin and in the rivers. Meteorology and hydrology data were obtained from the files of the Reservoir Control Center in Hydrology and Hydraulics Branch. The latest (at the time this report is being written) preliminary estimates of peak stages and discharges were obtained from the U. S. Geological Survey for this report. Damages caused by the flood are in the Flood Damages section of this report. Economic data used in damage estimates are based upon field observations taken by personnel from the Hydraulics and Economic & Social Evaluation Sections of Engineering Division. Appendixes A through D contains the flood fighting reports. Included are newspaper articles giving the local viewpoint on both flood events.

## BASIN DESCRIPTIONS

3. General. The three river basins covered in this report are located in northwest Washington State (plate 1). Together the Nooksack, Skagit, and Snohomish basins cover 90 percent of the drainage area between Puget Sound and the Cascades, and between Seattle and British Columbia, Canada. The headwaters of each of these basins originate high on the western slope of the Cascade mountain range. Generally, these rivers fall steeply as they descend through the predominantly forested Cascade mountains and then flatten out through the coastal lowlands before they empty into Puget Sound. Flooding problems are most evident in the more developed coastal lowlands.

a. Nooksack Basin. The Nooksack River basin (plate 2) is located in the uppermost northwest corner of the state and has a drainage area of 826 square miles, including 49 square miles in Canada. The North Fork of the river (293 square miles) is the main tributary, and is joined by the Middle Fork (102 square miles) to form the main stem river system. The main stem is then joined by the South Fork (183 square miles) about 5 miles farther downstream at Deming. Below Deming, the Nooksack meanders through 37 miles of coastal lowlands to Bellingham Bay. During high flows floodwaters from the Nooksack cross a low divide near Everson and flow northward into the Sumas River and then into Canada. The magnitude of these overflows has not been precisely determined, but is believed to occur when the Nooksack river exceeds 20,000 to 25,000 cfs. Aggradation of the river channel in this vicinity appears to be causing the overflow to occur at lower flowrates year after year.

The flood plain of the Nooksack involves several small cities and towns, sections of two main railway lines, a section of Interstate Highway 5, and numerous State, county, and local roadways, as well as agricultural lands and rural residences. There are no flood control dams within the basin, but there is a system of levees along the lower reaches of the river.

b. Skagit Basin. The Skagit River basin (plate 3), located to the south of the Nooksack basin, has a drainage area of 3,140 square miles. The northern end of the basin extends 28 miles into Canada, and covers 400 square miles. The headwaters of the Skagit arise in the steep Cascade mountains of Canada and flow west and south into the United States. The river continues to flow through steep mountains for the next 40 miles where it passes through Ross, Diablo, and Gorge Dams owned by Seattle City Light above the town of Newhalem and another 70 miles or so through less precipitous mountain valleys before emerging in the vicinity of Sedro Woolley. The river then meanders another 25 miles through the coastal lowlands to Skagit Bay. Before it reaches the bay, the river crosses a broad outwash plain and divides into two principle distributary branches, the north fork and the south fork, which are 7.3 miles and 8.1 miles long, respectively, and which normally carry 40 percent and 60 percent of the flow, respectively.

The Skagit is joined by its largest tributary, the Sauk River (732 square miles), below Rockport. A smaller tributary, the Baker River, flows into the Skagit near Concrete, about 10.7 miles below the Sauk River. The Baker River flows through Upper and Lower Baker Dams owned by Puget Sound Power and Light.

Several flood control projects provide flood protection in the Skagit basin. These include a system of levees in the lower basin and flood control reservoirs in the upper basin. Both Ross Dam on the Skagit, and Upper Baker on the Baker River, are operated on a formal basis for flood control and provide a significant reduction to large and small floods. These dams control 38 percent of the Skagit basin's drainage area. The other 62 percent is uncontrolled by flood control reservoirs. The remaining hydroelectric and reregulatory dams situated on the Skagit and Baker rivers provide incidental reduction of flood flows during smaller floods.

The flood plain of the Skagit River contains numerous medium to small size towns, many rural residences, a high degree of agricultural development, sections of two railway lines, a section of Interstate Highway 5 and Highway 20, several airfields, and various industries.

c. Snohomish Basin. The Snohomish River basin (plate 4) is located north and east of Seattle with a drainage area of 1,978 square miles. The Snohomish River is formed near Monroe, Washington by the confluence of its two major tributaries, the Skykomish River and the Snoqualmie River. Both major tributaries have their origin in the western slopes of the Cascade mountains and flow through narrow, heavily forested mountain valleys in the eastern portion of the basin. In the final 19 miles of the Skykomish and final 35 miles of the Snoqualmie River, the valleys widen and surrounding hills decrease in elevation. From the confluence of the Snoqualmie and Skykomish rivers, the Snohomish meanders around 20 miles through a 1- to 3-mile-wide valley with a very flat gradient, marshes, and tidal lowlands before it finally empties into Possession Sound.

The Skykomish River is the largest tributary with a drainage area of 844 square miles, while the Snoqualmie has a drainage area of 693 square miles.

Urban, suburban, and industrial developments adjacent to the cities in the basin extend into the flood plain. The flood plain of these three rivers includes parts of ten small to medium size towns

as well as parts of Everett. Other development in the flood plain includes agricultural land, domestic dwellings, farm buildings, highways, utilities and railroads. Although several small water supply and hydroelectric projects provide some incidental flood reduction no flood control reservoirs are located in the Snohomish basin. A system of levees provides flood protection in the lower basin.

## METEOROLOGY

### 4. Antecedent Weather, November 9-12.

a. Rainfall. Precipitation amounts in western Washington during the month of October were as much as 200 percent of normal. Hence, ground conditions were primed to saturation in advance of the actual rainfall which caused flooding during this November 1990 (Veterans Day) flood event.

b. Snowpack. Another factor contributing to the runoff was the healthy early season snowpack which was about 200 percent of normal. At the beginning of the event, the snowline was about 2,000 feet mean sea level with an excess of 2 inches of water in the pack above 2,500 feet. The pack was "prime" and ready to melt.

5. Synoptic Conditions, November 9-12. Although the antecedent conditions were favorable for a flood event, two synoptic conditions working together were the primary cause of this flood. These two conditions were the air mass characteristics and the jet stream.

a. Air Mass. During the period November 9 through 13, 1990, western Washington was dominated by a warm, moist subtropical air mass whose source region was an area just north of the Hawaiian Islands. This source region has over the years been dubbed the "Pineapple Express" due to its propensity for sending very warm and very moist semitropical air to the mid-latitudes, especially the Pacific Northwest.

b. Jet Stream. During this entire period, the polar jet stream was vigorous, strong, and extraordinarily persistent. The core of the jet was generally oriented southwest to northeast and aimed at southern British Columbia and northern Washington. Maximum winds in the core of the jet were always in excess of 100 knots and at times were in the 170-190 knot range.

### 6. Resulting Weather, November 9-12.

a. Precipitation. Heavy and intense rains fell in western Washington during the 3-day period of November 8 through 10. Due to the strength and location of the core of the polar jet stream and the resulting wind structure at lower levels, the rains were highly orographic in nature. Heaviest rainfall centered in the Cascade Mountains from the Snoqualmie basin northward into Canada. The rains tapered off quite dramatically in the southern Cascades with the White River at Mud Mountain Dam receiving only about 2 inches during those 3 days. Rainfall amounts over the 3-day period at principal precipitation stations in the Nooksack, Skagit, Stillaguamish, and Snohomish watersheds are listed in table 1.



Table 1 - Precipitation during 8-11 November 1990 (inches)

| River         | Precipitation<br>Station | Dates in November 1990 |      |     |     |       |
|---------------|--------------------------|------------------------|------|-----|-----|-------|
|               |                          | 8                      | 9    | 10  | 11  | Total |
| Nooksack      | Glacier                  | 0.8                    | >0.8 | N/A | N/A | N/A   |
| Sauk          | Darrington               | 0.9                    | 4.2  | 1.2 | 0.1 | 5.8   |
| Skagit        | Marblemount              | 0.9                    | 6.1  | 2.5 | 0.1 | 9.6   |
| Skagit        | Diablo                   | 4.0                    | 7.3  | 1.0 | --  | 12.3  |
| Stillaguamish | Verlot                   | 0.4                    | 4.5  | 1.2 | --  | 6.1   |
| Skykomish     | Skykomish                | 1.1                    | 6.7  | 1.7 | 0.1 | 9.6   |
| Snoqualmie    | Snoqualmie Pass          | 1.4                    | 6.8  | 1.6 | 0.5 | 10.3  |
| Snoqualmie    | Snoqualmie Falls         | 0.3                    | 4.0  | 0.5 | 0.0 | 4.8   |

## Notes:

1. Precipitation amounts were obtained from U.S. Weather Service except for Verlot which was measured from 3:00 p.m. on 8 November to 10:00 a.m. on 10 November and Diablo which was measured from 8:00 a.m. to 8:00 a.m., daily, by Seattle City Light.

2. In addition to the above amounts, Ross Dam in the Skagit basin, reported a 24-hour rainfall amount of 9 inches, which is nearly a 100-year rainfall event according to the Climatological Handbook, Columbia Basin States, Precipitation Vol 2.

b. Snowmelt. Prior to the event, the freezing level was about 4,000 feet in western Washington but quickly jumped to 9,000-10,000 feet with the arrival of the "Pineapple Express." The freezing level stayed above 9,000 feet until November 13 and then dropped to about 3,000 feet late on November 14. Warm air and rain falling on the snowpack melted an average of about 2 inches of water from the snowpack in the mountainous regions between about 2,500 feet and 5,500 feet. Runoff volume from snowpack was on the order of 10,000 acre-feet of water in each of several western Cascade basins. So, snowmelt contributed significantly to the severity of the flooding in the basins discussed in this report.

7. Antecedent Weather, November 21-26. One factor in the high runoff observed for this Thanksgiving Day weekend flood event was the Veterans Day weekend flood in western Washington 2 weeks earlier. There was still substantial standing water in many of the basins west of the Cascades. Hence, ground conditions were prime for another flood event.

8. Synoptic Conditions, November 21-26. A persistent low pressure system in the Gulf of Alaska generated a series of frontal systems that tracked across the Pacific Northwest during the period from November 21 through 26, 1990. Normally there is a pool of heavy cold air that follows these frontal systems and forces them over the Cascades and into the Rocky Mountains.

Unfortunately, these frontal systems lacked sufficient cold air to drive them swiftly through the region. As a result, the systems were slow moving and stalled in the Cascades, allowing the orographic rains to continue much longer than normal.

9. Resulting Weather, November 21-26.

a. Precipitation. Copious amounts of rain fell in western Washington during the 6-day period of November 21 through 26. Most stations in the Cascades received at least 6 inches. Precipitation amounts for the Nooksack, Skagit, Snohomish, and Stillaguamish River basins are shown in table 2. The cumulative rainfall for this event was greater than the Veterans Day weekend event, but the Veterans Day weekend event did have periods of much greater intensity.

Table 2 - Precipitation during 21-25 November (inches).

| River         | Precipitation Station | Dates in November 1990 |     |     |      |     |       |
|---------------|-----------------------|------------------------|-----|-----|------|-----|-------|
|               |                       | 21                     | 22  | 23  | 24   | 25  | Total |
| Nooksack      | Glacier               | 0.9                    | 3.5 | 4.4 | 2.1  | 0.1 | 11.0  |
| Skagit        | Marblemount           | 1.0                    | 2.5 | 1.0 | 2.2  | 0.3 | 6.0   |
| Skagit        | Diablo                | 2.8                    | 3.5 | 5.8 | 3.2  | 0.2 | 15.5  |
| Sauk          | Darrington            | 1.4                    | 1.9 | 3.3 | 4.1  | 0.6 | 11.3  |
| Stillaguamish | Verlot                | 1.2                    | 2.2 | 2.3 | 2.9  | 1.0 | 9.6   |
| Skykomish     | Skykomish             | 1.9                    | 2.9 | 4.3 | >3.3 | N/A | N/A   |
| Snoqualmie    | Snoqualmie Pass       | 1.7                    | 2.8 | 4.4 | 5.3  | 0.7 | 14.9  |
| Snoqualmie    | Snoqualmie Falls      | 0.6                    | 1.1 | 1.7 | 3.9  | 0.3 | 7.6   |

Note:

1. Precipitation amounts were obtained from U.S. Weather Service except for Verlot which was obtained from the Corps flood monitoring record and Diablo which was measured from 8:00 a.m. to 8:00 a.m., daily, by Seattle City Light.

b. Snowmelt. Although the snowpack had built back up after the November 8-10 flood, the freezing level stayed quite low during the week of the event. Hence, although an average of 2 to 3 inches of water melted from the snowpack in the lower parts of the basins, the snowpack above 4,000 feet actually increased during the flood event. So, snowmelt did not contribute significantly to the severity of the Thanksgiving Day weekend flood in western Washington.

## HYDROLOGY

10. Hydrologic Data. Hydrologic data for the primary streamgages in the three basins is summarized in table 3 for the Veterans Day weekend flood and in table 4 for the Thanksgiving Day weekend flood. Included in these tables are the peak stage and flow, time of the peak, associated return period, drainage area, distance from the mouth to the gage, duration of flooding, and the

**TABLE 3 - HYDROLOGIC DATA FOR NORTHWEST WASHINGTON BASINS  
VETERANS DAY FLOOD, 8-12 NOVEMBER 1990**

| BASIN<br>STREAM<br>LOCATION | USGS ID * | RIVER<br>MILE<br>miles | DRAIN<br>AREA,<br>square<br>miles | EVENT,<br>day:hour | PEAK<br>STAGE<br>feet | PEAK<br>FLOW,<br>cfs | RETURN<br>PERIOD,<br>years | ZERO/<br>MAJOR<br>DAMAGE<br>ft/ft | HRS ABV<br>ZERO/MAJ<br>DAMAGE,<br>hrs/hrs |
|-----------------------------|-----------|------------------------|-----------------------------------|--------------------|-----------------------|----------------------|----------------------------|-----------------------------------|-------------------------------------------|
| Snohomish                   |           |                        |                                   |                    |                       |                      |                            |                                   |                                           |
| Skykomish                   |           |                        |                                   |                    |                       |                      |                            |                                   |                                           |
| Gold Bar                    | 12134500  | 43.0                   | 535                               | 10:0700            | 21.1                  | 86,800               | 20                         | 15/19                             | 37/21                                     |
| Snoqualmie                  |           |                        |                                   |                    |                       |                      |                            |                                   |                                           |
| Carnation                   | 12149000  | 23.0                   | 603                               | 10:1200            | 59.42                 | 52,300               | 10                         | 54/58                             | 48/19                                     |
| Snohomish                   |           |                        |                                   |                    |                       |                      |                            |                                   |                                           |
| Monroe                      | 12150800  | 20.4                   | 1,537                             | 10:2000            | 21.75                 | 101,200              | 15 <sup>s</sup>            | 14/17                             | 64/48                                     |
| Snohomish                   | 12155500  | 12.7                   | 1,714                             | 10:1900            | 32.69 <sup>b</sup>    | 88,000 <sup>b</sup>  | 5                          | 25/29                             | 62/42                                     |
| Skagit                      |           |                        |                                   |                    |                       |                      |                            |                                   |                                           |
| Skagit                      |           |                        |                                   |                    |                       |                      |                            |                                   |                                           |
| Concrete                    | 12194000  | 54.1                   | 2,737                             | 10:1500            | 40.20                 | 148,800              | 21                         | 28/32                             | 106/42                                    |
| Mt Vernon                   | 12200500  | 15.7                   | 3,093                             | 11:1000            | 36.60                 | 142,000              | 17                         | 28/30                             | 83/53                                     |
| Nooksack                    |           |                        |                                   |                    |                       |                      |                            |                                   |                                           |
| Nooksack                    |           |                        |                                   |                    |                       |                      |                            |                                   |                                           |
| Deming                      | 12210500  | 36.6                   | 584                               | 11:HWMM            | 15.40                 | 40,000 <sup>c</sup>  | 11                         | 12/15                             | 48/ 7                                     |
| Ferndale                    | 12213100  | 5.8                    | 786                               | 11:1200            | 23.59                 | 55,000 <sup>f</sup>  | 33                         | N/A                               | N/A                                       |

\* 1990 data provided by USGS except for 12155500 which was from NWS. All data are subject to revision.  
r New flood of record.

s Based on stage frequency curve.

e Estimated.

b Values are affected by tides.

HWMM High Water Mark.

TABLE 3

| TABLE 4 - HYDROLOGIC DATA FOR NORTHWEST WASHINGTON BASINS<br>THANKSGIVING DAY FLOOD, 21-26 NOVEMBER 1990 |           |               |                         |                   |                       |                       |                            |                                   |                                          |
|----------------------------------------------------------------------------------------------------------|-----------|---------------|-------------------------|-------------------|-----------------------|-----------------------|----------------------------|-----------------------------------|------------------------------------------|
| BASIN<br>STREAM<br>LOCATION                                                                              | USGS ID * | RIVER<br>MILE | DRAIN<br>AREA,<br>sq mi | EVENT,<br>dy;hour | PEAK<br>STAGE<br>feet | PEAK<br>FLOW<br>cfs   | RETURN<br>PERIOD,<br>years | ZERO/<br>MAJOR<br>DAMAGE<br>ft/ft | HRS ABV<br>ZERO/MAJ<br>DAMAGE<br>hrs/hrs |
| Snohomish                                                                                                |           |               |                         |                   |                       |                       |                            |                                   |                                          |
| Skykomish                                                                                                |           |               |                         |                   |                       |                       |                            |                                   |                                          |
| Gold Bar                                                                                                 | 12134550  | 43.0          | 535                     | 24;0700           | 22.49                 | 101,600 <sup>f</sup>  | 33                         | 15/19                             | 38/26                                    |
| Snoqualmie                                                                                               |           |               |                         |                   |                       |                       |                            |                                   |                                          |
| Carnation                                                                                                | 12149000  | 23.0          | 603                     | 25;0000           | 60.61                 | 73,100 <sup>f</sup>   | 50                         | 54/58                             | 87/31                                    |
| Snohomish                                                                                                |           |               |                         |                   |                       |                       |                            |                                   |                                          |
| Monroe                                                                                                   | 12150800  | 20.4          | 1,537                   | 25;0600           | 25.42                 | 135,500 <sup>fc</sup> | 80 <sup>s</sup>            | 14/17                             | 100/58                                   |
| Snohomish                                                                                                | 12155500  | 12.7          | 1,714                   | 25;1100           | 33.33                 | 165,000 <sup>fc</sup> | 80                         | 25/29                             | 105/50                                   |
| Skagit                                                                                                   |           |               |                         |                   |                       |                       |                            |                                   |                                          |
| Skagit                                                                                                   |           |               |                         |                   |                       |                       |                            |                                   |                                          |
| Concrete                                                                                                 | 12194000  | 54.1          | 2,737                   | 24;1400           | 39.89                 | 146,000               | 20                         | 28/32                             | 68/39                                    |
| Mt Vernon                                                                                                | 12200500  | 15.7          | 3,093                   | 25;1200           | 37.40                 | 155,000               | 40                         | 28/30                             | 72/54                                    |
| Nooksack                                                                                                 |           |               |                         |                   |                       |                       |                            |                                   |                                          |
| Nooksack                                                                                                 |           |               |                         |                   |                       |                       |                            |                                   |                                          |
| Deming                                                                                                   | 12210500  | 36.6          | 584                     | 24;0500           | 14.59                 | 35,000 <sup>e</sup>   | 6                          | 12/15                             | 28/0                                     |
| Ferndale                                                                                                 | 12213100  | 5.8           | 786                     | 24;0600           | 22.38                 | 49,000                | 15                         | N/A                               | N/A                                      |

\* 1990 data provided by USGS except for 12155500 which was from NWS. All data are subject to revision.

r New flood of record.

s Based on stage frequency curve.

e Estimated.

c COE value was 186,000 cfs.

TABLE 4

**TABLE 5 - HYDROLOGIC DATA FOR NORTHWEST WASHINGTON BASINS  
HISTORICAL COMPARISON OF NOVEMBER 1990 FLOODS**

| BASIN<br>STREAM<br>LOCATION | USGS ID * | NOV '90<br>EVENT,<br>dyr:hour | PEAK<br>STAGE<br>feet | PEAK<br>FLOW,<br>cfs | RETURN<br>PERIOD,<br>years | RECORD<br>FLOOD<br>mm/dy/yr | PEAK<br>STAGE,<br>feet | PEAK<br>FLOW,<br>cfs | RETURN<br>PERIOD,<br>years |
|-----------------------------|-----------|-------------------------------|-----------------------|----------------------|----------------------------|-----------------------------|------------------------|----------------------|----------------------------|
| Snohomish                   |           |                               |                       |                      |                            |                             |                        |                      |                            |
| Skykomish                   |           |                               |                       |                      |                            |                             |                        |                      |                            |
| Gold Bar                    | 12134500  | 24:0700                       | 22.49                 | 101,600 <sup>f</sup> | 33                         | 12/26/80                    | 21.38                  | 90,400               | 25                         |
| Wallace                     |           |                               |                       |                      |                            |                             |                        |                      |                            |
| Gold Bar                    | 12135000  | 10:0600                       |                       | 3,120                | 5                          | 1/ 5/69                     | 8.37                   | 3,400                | 8                          |
| Raging                      |           |                               |                       |                      |                            |                             |                        |                      |                            |
| Fall City                   | 12145500  | 24:1300                       | 6.34                  | 5,540 <sup>f</sup>   | 100 <sup>u</sup>           | 11/23/86                    | 6.27                   | 5,330                | 80 <sup>u</sup>            |
| Tolt                        |           |                               |                       |                      |                            |                             |                        |                      |                            |
| Carnation                   | 12148500  | 24:0800                       | 11.62                 | 11,200 <sup>f</sup>  | 16                         | 12/15/59                    | 13.15                  | 9,560                | 9                          |
| Snoqualmie                  |           |                               |                       |                      |                            |                             |                        |                      |                            |
| M.F.Tanner                  | 12141300  | 24:1500                       | 14.97                 | 30,100               | 23 <sup>u</sup>            | 11/23/59                    | 18.7                   | 49,000               | 100 <sup>u</sup>           |
| N.F.Srq.Fls                 | 12142000  | 24:0900                       | 12.05                 | 12,000               | 8                          | 2/26/32                     | 17.5                   | 15,800               | 25                         |
| Snoqualmie                  | 12144500  | 24:HWM                        | 21.10                 | 74,300 <sup>f</sup>  | 60                         | 11/23/59                    | 19.78                  | 61,000               | 23                         |
| Carnation                   | 12149000  | 25:0000                       | 60.61                 | 73,100 <sup>f</sup>  | 50                         | 2/27/32                     | 59.88                  | 59,500               | 18                         |

\* 1990 data provided by USGS except for 12155500 which was from NWS. All data is subject to revision.

r New flood of record.

e estimated.

u Uncertain of this value. Frequency curve needs to be updated.

s Based on stage frequency curve.

c COE value was 186,000 cfs.

HWM High Water Mark

**TABLE 5 - HYDROLOGIC DATA FOR NORTHWEST WASHINGTON BASINS  
HISTORICAL COMPARISON OF NOVEMBER 1990 FLOODS**

| BASIN<br>STREAM<br>LOCATION | USGS ID * | NOV '90<br>EVENT,<br>dy:hour | PEAK<br>STAGE<br>feet | PEAK<br>FLOW,<br>cfs | RETURN<br>PERIOD,<br>years | RECORD<br>FLOOD<br>mm/dy/yr | PEAK<br>STAGE,<br>feet | PEAK<br>FLOW,<br>cfs | RETURN<br>PERIOD,<br>years |
|-----------------------------|-----------|------------------------------|-----------------------|----------------------|----------------------------|-----------------------------|------------------------|----------------------|----------------------------|
| Shohomish                   |           |                              |                       |                      |                            |                             |                        |                      |                            |
| Monroe                      | 12150800  | 25:0600                      | 25.42                 | 186,000 <sup>c</sup> | 80 <sup>s</sup>            | 12/04/75                    | 22.92                  | 141,000 <sup>c</sup> | 25 <sup>s</sup>            |
| Shohomish                   | 12155500  | 25:1100                      | 33.33                 | 165,000 <sup>e</sup> | 80                         | 2/10/51                     | 31.12                  | 136,000              | 40                         |
| Skagit                      |           |                              |                       |                      |                            |                             |                        |                      |                            |
| Sauk                        |           |                              |                       |                      |                            |                             |                        |                      |                            |
| Sauk                        | 12189500  | 24:1830                      | 16.93                 | 82,400               | 60 <sup>u</sup>            | 12/26/80                    | 18.24                  | 98,600               | 133 <sup>u</sup>           |
| Skagit                      |           |                              |                       |                      |                            |                             |                        |                      |                            |
| Concrete                    | 12194000  | 10:1500                      | 40.20                 | 148,800              | 21                         | 11/27/49                    | 40.8                   | 154,000              | 25                         |
| Mt Vernon                   | 12200500  | 25:1200                      | 37.40                 | 155,000 <sup>f</sup> | 40                         | 2/11/51                     | 36.85                  | 144,000              | 17                         |
| Nooksack                    |           |                              |                       |                      |                            |                             |                        |                      |                            |
| Nooksack                    |           |                              |                       |                      |                            |                             |                        |                      |                            |
| Deming                      | 12210500  | 11:0900                      | 15.40                 | 40,000               | 11                         | 02/10/51                    | 15.7                   | 43,200 <sup>x</sup>  | 18                         |
| Ferndale                    | 12213100  | 11:1200                      | 23.59                 | 55,000 <sup>f</sup>  | 33                         | 12/ 3/75                    | 21.97                  | 52,700               | 25                         |

\* 1990 data provided by USGS except for 12155500 which was from NWS. All data is subject to revision.

r New flood of record.

e estimated.

u Uncertain of this value. Frequency curve needs to be updated.

s Based on stage frequency curve.

c COE values. The USGS values were 135,500 cfs in 1990 and 115,000 cfs in 1975.

x Extremes outside the period of record include: 20 ft in 1908; 16.8 ft in 1909; 16.8 ft for 49,300 cfs in 1932.

HWM High Water Mark

zero and major damage levels. In table 5 maximum peak discharges and their associated return periods for November 1990 are compared with peak flows and return periods for record floods of the past. All streamgages included in this report are operated by the United States Geological Survey (USGS) except for station 12155500 which is maintained by the National Weather Service. The data presented in table 3 and 4 were originally collected by the Corps during the November flood events and updated based on the latest available data from the USGS. The data presented in these tables have not yet been officially published by the USGS and are therefore subject to change. Any revisions in the data are not expected to be significant.

11. Nooksack, November 9-12. A flood watch was issued on Thursday, November 8, 1990 for the Nooksack and Skagit River basins. It indicated that the rivers could reach flood stage by late Friday but flooding was not necessarily imminent. A storm in the Pacific was expected to move slowly across British Columbia and northern Washington. By 9:15 a.m. on Friday, November 9, 1990, with over 4 inches of rain already fallen in some northern portions of western Washington, a flood warning for the Nooksack, Skagit, Snoqualmie, and Skykomish River basins was issued. In a 48-hour period beginning on November 8 and ending on November 10 over 6 inches of rain fell at the Darrington gage and over 9 inches fell at the Marblemount gage. The Glacier Station raingage malfunctioned on November 9 and did not provide readings for the rest of the storm.

a. South Fork. The South Fork of the Nooksack responded very quickly to the intense rainfall with the gage near Wickersham going from a flow of 1,960 cubic feet per second (cfs) at 2:00 a.m. to a peak flow of 19,800 cfs, by 6:00 p.m. on November 9. The flow near Wickersham receded steadily back to 15,000 cfs and then regained some discharge to have a flatter secondary peak of 16,800 cfs at 11:00 a.m. on November 10. It receded rather steadily from then on and was back down to a flow of 2,300 cfs by noon on November 12. More rain fell during November 12 which brought the flow back up to 10,700 cfs at 8:00 a.m. on the thirteenth and then quickly receded.

The peak flow near Wickersham of 19,800 cfs had a return period of 30-years and was a new record for the period of observation, 1933-1990. The old record was 19,300 cfs on November 3, 1955. It is interesting to note that both record peaks occurred in early November.

b. North Fork. On the North Fork at Glacier the discharge went from 880 cfs at 2:00 a.m. up to 8,890 cfs by 7:30 p.m. on November 9. After receding to 8,320 cfs, the flow at Glacier rebounded to a peak flow of 9,100 cfs at 9:30 a.m. on November 10. The corresponding return period for this flow is 12 years. The flow at Glacier receded rather slowly with the flow still above 6,500 cfs by 12:00 Midnight on the tenth. After receding to 2,520 cfs by 4:30 p.m. on November 12 the discharge went back up to 6,700 cfs by 7:00 a.m. on November 13 due to the latent shot of rain on November 12.

c. Deming. At 10:00 p.m. on November 9 the Nooksack River at Deming reached the zero damage flood stage of 12 feet and was still climbing by about  $\frac{1}{2}$  foot per hour. By 8:00 p.m. the stage stabilized at about 14.7 feet until about 8:00 a.m. on November 10 when it began to rise toward 15 feet. The river stage was at or slightly above the major damage flood stage of 15 feet from 10:00 a.m. until about 2:00 p.m. on November 10 and was above flood stage of 12 feet for about 48 hours. The peak stage at Deming was 15.4 feet with an estimated discharge of 40,000 cfs and an estimated return period of 11 years. The river receded steadily except for a 12-hour rise to just above 12 feet during the first half of the thirteenth.

d. Ferndale. At the Ferndale gage the peak stage of 23.59 feet which was reached at 12:00 noon on November 11. This corresponds to a discharge of 55,000 cfs with a return period of 33 years which would indicate a new flood of record for the period 1966-1991. The stage recorder malfunctioned during this event so the stage readings are not available between 2:00 p.m. on November 10 and 11:00 a.m. on November 11. Problems with aggradation and tides in this reach of the river cast some measure of uncertainty on the stage/discharge relationship at the Ferndale gage. Previous investigations have indicated no significant tidal effects at the Ferndale gage. For this event the high tide occurred around the same time the Ferndale gage peaked which may indicate some interaction between the two.

e. Overflow into the Sumas. Just south of Everson, river mile 23.8, a portion of the flow in the Nooksack river overflows into the Sumas basin. Large amounts of water flowed into the communities of Everson, Nooksack, and Sumas and caused severe flooding during the Veterans Day weekend. Water was first observed crossing into the Sumas basin at 3:00 p.m. November 9. The flow at Deming was 31,200 cfs at 3:00 pm. Discharge travel time from Deming to Everson is between 6 to 7 hours, so a fair estimate of the discharge at Everson when overflow occurred would be about 20,000 cfs--the flow rate at Deming 6 to 7 hours earlier.

12. Skagit, November 9-12. Rain began in the Skagit basin in the early afternoon of November 8 and continued to fall through November 10. It became apparent early November 9 that a flood was imminent as river discharges throughout the basin began rising significantly.

a. Concrete. The Skagit River at the Concrete gage went above the zero damage stage of 28 feet (62,500 cfs) at 1:00 p.m. and continued above the major damage stage of 32 feet (90,000 cfs) by 6:00 p.m. on Friday, November 9. At 1:00 p.m. on November 10 the river crested at 40.20 feet which corresponds to a peak discharge of 148,800 cfs and a return interval of 21 years. The river stage at Concrete remained above major damage for 42 hours and above zero damage for 106 hours.

b. Mount Vernon. The Skagit River at the Mount Vernon gage exceeded the zero damage stage of 28 feet (68,000 cfs) early November 10 at 3:00 a.m. and the major damage stage of 30 feet (80,200 cfs) by noon. By 8:00 p.m. on the tenth the river rose to a stage of 34 feet, 112,000 cfs. And by 10:00 a.m. on Sunday, November 11, the flood peaked at Mount Vernon with a crest stage of 36.60 feet, a peak flow of 142,000 cfs, and a return interval of 17 years. Time above zero and major damage was 83 and 53 hours, respectively.

c. Flood Control Regulation. Flood control regulation by the U.S. Army Corps of Engineers (the Corps) of the Skagit and Baker River projects prevented major flood damages in the lower Skagit River valley and Mount Vernon areas. Seattle City Light (Ross Dam on the Skagit River) and Puget Sound Power and Light (Upper Baker Dam on the Baker River) effectively responded to the Corps' flood control regulation operations. Flood control regulation of the projects was initiated by the Corps at 11:00 a.m. Friday November 9 and did not end until the first week of December. Water levels at both projects were well below their flood control pool elevations at the onset of the flood and filled to within about a half a foot of full pool during the event, using 112,000 acre-feet (AF) at Ross and 82,000 AF at Upper Baker.



d. Effects of Flood Control Regulation. Flood control regulation of Ross and Upper Baker reduced flood levels by an estimated 3 feet at the Mount Vernon gage. On Saturday, November 10 the peak inflow to Ross was about 46,000 cfs at 12:00 p.m. At Upper Baker the peak inflow was about 33,000 cfs at 10:00 a.m. the same day. Releases from both projects were limited to 5,000 cfs or less until it was certain that Skagit River inflows and discharges were receding. By 6:00 p.m. on November 10 the local inflows below Ross were receding. In order to reduce the rate of rise of the Ross pool elevation the outflow from the project was increased to maintain a discharge of 21,000 cfs at the Newhalem gage. At 9:00 p.m. November 10 the Ross pool elevation was at 1,599.38 feet and had an inflow of about 40,000 cfs. Early on November 11 discharges up to 11,000 cfs were released based on the spillway gate regulation schedule (SGRS) to prevent overtopping the Dam. No surcharge storage was induced, however, because the flood began to recede and to make it possible to increase discharges beyond those dictated by the SGRS. Maximum discharge from Ross was about 24,000 cfs on November 12.

e. Reservoir Storage Evacuation. Evacuation of stored floodwater at both projects proceeded as rapidly as possible based on downstream recession rates and various downstream flow restrictions. Several homes near Rockport were flooded during the period of highest flows. To prevent any more damage to these homes Ross outflows were regulated to maintain the stage at Rockport to at least 1 foot below the peak stage already experienced. In addition, water levels above a certain stage at Newhalem were causing minor flooding of Highway 20. To prevent damage and to avoid closing the highway, releases from Ross were limited accordingly. Also of concern was the problem of boils and seepage behind the levees in the lower valley when the river stage at the Mount Vernon gage is above 34 feet. To help minimize this problem appropriate outflows from the projects were made to bring the river below 34 feet at Mount Vernon as expeditiously as possible.

13. Snohomish, November 9-12. A flood warning was issued for the Skykomish and Snohomish River basins at 7:00 a.m. Friday November 9. One was issued for the Snoqualmie River basin by 9:00 a.m. the same day.

a. Skykomish River. The Skykomish River at Gold Bar was already rising over a foot an hour and reached zero damage flood stage of 15 feet by 9:30 a.m. The river passed the major damage elevation of 19 feet at Gold Bar by 3:00 p.m. and peaked at 21.1 feet at 7:00 a.m. on November 10. The peak discharge for this event was 86,800 cfs with a corresponding return interval of 20 years.

14. Middle Fork and North Fork Snoqualmie. Both the Middle Fork Snoqualmie and the North Fork Snoqualmie contributed peak flows having 5-year return intervals. The Middle Fork near Tanner peaked at 21,000 cfs at 11:00 p.m. November 9. The North Fork near Snoqualmie Falls had a peak flow of 10,300 at the same time, 11:00 p.m., November 9. On the South Fork near Garcia the river hit a peak discharge of 6,240 cfs at 10:00 p.m. and then crested downstream at Edgewick 2 hours later with a peak flow of 8,320 cfs.

a. Snoqualmie River near Snoqualmie. The Snoqualmie River near Snoqualmie crested at 4:00 a.m. on November 10 with a maximum discharge of 49,100 cfs, which is equivalent to an

8-year event. And at 10:00 p.m. on November 9 the peak discharge on the Raging River near Fall City went up to 3,900 cfs.

b. Tolt River. The flow on the Tolt River near Carnation gage is affected by storage at the Tolt reservoir on the South Fork. The South Fork Tolt River above Tolt reservoir peaked at 10:00 a.m. November 9 with a flow of 1,390 cfs. At 7:00 a.m. November 8, before the outset of the flood, the Tolt Reservoir elevation was 1,752.26 feet and at 7:00 a.m. on the ninth the pool elevation was 1,754.85 feet. By 7:00 a.m. November 10 the water surface was at 1,762.24 feet and continued to rise and reached its maximum during the Thanksgiving Day weekend flood. The full pool overflow elevation is 1,762.00 feet. So, from early on the tenth the reservoir began spilling. Although the reservoir did not provide controlled regulation of the event it did keep the peak flow below the dam to only 614 cfs (4:00 a.m. on November 11). Some attenuation of flow did occur as it passed through the reservoir. The North Fork Tolt is not regulated and attained a peak flow of 6,640 cfs on November 9 at 1:00 p.m. Discharge on the main stem of the Tolt River near Carnation reached 7,100 cfs which is about a 4-year regulated event.

c. Snoqualmie River near Carnation. The Snoqualmie River near Carnation went above the zero damage stage of 54 feet around 7:00 p.m. November 9, above major damage flood stage of 58 feet by 4:00 a.m. November 10, and peaked at a stage of 21.1 feet at 12:00 noon on the tenth. The associated peak flow was 52,300 cfs with a return period of 10 years.

d. Snohomish River. The Snohomish River is affected by runoff from its two main tributaries, the Snohomish and the Skykomish Rivers. The timing of the peak flows from these two main tributaries can greatly affect the magnitude of the peak flow experienced on the Snohomish. During this event the peak flow from the Skykomish reached the Snohomish River 9 to 10 hours ahead of the peak flow from the Snoqualmie River, thereby reducing the combined impact of flows from these two rivers. The Snohomish River at Monroe experienced a maximum stage of 21.75 feet with a corresponding peak discharge of 101,200 cfs and a return interval of 15 years. The river was above zero damage stage of 14 feet for 64 hours beginning at 3:00 p.m. on the ninth, and was above major damage stage of 17 feet for 48 hours beginning at 9:00 p.m. on the tenth. All three rivers receded steadily after peaking and were well below flood stage by midnight November 12.

15. Nooksack, November 21-26. Before all the water from the Veterans Day weekend flood had finished draining from each of the western Washington river basins another weather system came storming into the region in time for the Thanksgiving Day weekend. The northernmost basins such as the Nooksack and Skagit did not receive as much rain during this second event but still experienced significant flooding. Both basins were still well saturated from the last flood. The first flood warning came at about noon on November 21. At 6:00 a.m. that morning precipitation at the Darrington gage began to accumulate at about 0.1 inch per hour and continued until 6:00 p.m. on the 22nd.

a. South Fork Nooksack. The South Fork of the Nooksack took exception from the rest of the basin. The flow near Wickersham was greater for this event than for the November 9-12 event. The peak flow was 22,400 cfs and established, yet again, a new flood of record. The

associated return period was 60 years. The frequency curve used here is out of date and may change if updated using all the data now available.

b. North Fork Nooksack. The peak discharge on the North Fork at Glacier was 7,490 cfs with a corresponding return period of 5 years. Flow on the North Fork increased more slowly than it did during the November 9-12 event and had a broad peak which lingered above 6,500 cfs for 17 hours. After the peak was reached the flow receded steadily.

c. Deming. The discharge on the Nooksack River at Deming began to respond to accumulating precipitation at about 6:00 a.m. on November 22 and then climbed to a stage of 11.3 feet 24 hours later. After a short recession to a stage of 10 feet at 2:00 p.m. the flow rebounded and rose to a peak stage of 14.59 feet at 5:00 a.m. on November 24. The estimated peak flow of 35,000 cfs had a return interval of 5 years. After peaking nearly a half a foot below major damage the flow receded steadily to below zero damage flood stage by 11:00 p.m. November 24. The river was above zero damage flood stage of 12 feet for 28 hours.

d. Ferndale. The gage at Ferndale on the Nooksack River was out from November 14-25. The peak stage of 22.38 feet which occurred the morning of 24 November was obtained from the high water mark. The peak discharge was 49,000 cfs with a 15-year return interval. Again, this gage has some uncertainty associated with it as discussed earlier in paragraph 11.d.

16. Skagit, November 21-26. Rain began to accumulate the morning of November 21 and continued at the rate of about 0.1 to 0.2 inch per hour until noon on November 22. Only 0.3 inch was recorded at Marblemount during the next 24 hours. But then accumulations of 0.1 to 0.3 inch per hour were recorded for the next 24 hours. In the Skagit basin total precipitation accumulations were less for this event than for the November 9-12 event and hourly accumulations were generally less intense. The ground was still well saturated and portions of the basin still had standing water from the November 9-12 flood.

a. Concrete. The discharge at the Concrete gage responded to the rainfall and began to rise early on November 22. The river worked its way to just above zero damage flood stage by 4:00 a.m. on the 23rd. It leveled off at 28.4 feet and then receded to just below 28.0 feet before rising steadily to a peak stage of 39.89 feet by 6:00 p.m. November 24. The discharge receded steadily after the peak.

b. Mount Vernon. The Skagit River at the Mount Vernon gage began to rise by 7:00 a.m. November 22 and rose past zero damage flood level by 6:00 p.m. the next day. It crossed the major damage flood stage about 24 hours later and peaked at 37.40 feet to establish a new flood of record on November 25 at noon for the period of record 1940-1991. A steady recession brought the flow below major damage by 11:00 a.m. and below zero damage by 5:00 p.m. on November 26.

c. Flood Control Regulation. Ross and Upper Baker multipurpose reservoirs were again effectively used in diminishing the impact of flooding for this event. Flood control regulation by the Corps for the Veterans Day weekend flood was not totally complete when forecasts for the

Thanksgiving Day weekend event were beginning to come in. Flood control regulation by the Corps continued from one event right into the next. Upper Baker was drafted to elevation 707.5 feet (below normal winter flood control pool of 707.9 feet) and Ross was drafted to 1,592.0 feet (normal winter flood control pool) by midday November 22 in anticipation of the forecast flood. Storage of flood waters began to slowly fill both projects late on November 22. As inflows rose and regulated discharges were reduced the rate of storage accelerated. Ross reached a maximum elevation of 1,600.4 feet before evacuation began around 7:00 a.m. on November 26. It was just 2.1 feet below normal full pool and used 80 percent of its flood control storage. Upper Baker filled to within 3.3 feet of normal full pool to elevation 720.7 feet before evacuation began at 9:00 a.m. November 27. Upper Baker filled 79 percent of the allotted flood control storage.

The regulated discharge from Ross was reduced to minimum powerhouse discharge of 5,000 cfs at 1:00 p.m. November 22 and held at or below that rate through November 10. At Upper Baker the discharge was reduced to 5,000 cfs at 11:00 p.m. November 22 and held at that rate until the morning of November 27. Neither project required the use of their respective Spillway Gate Regulation Schedules. Evacuation of stored floodwater at both projects proceeded as rapidly as possible based on downstream recession rates. Several other flow restrictions limited discharge rates as discussed in paragraph 12.e.

d. Effects of Flood Control Regulation. The maximum inflow into Ross reservoir was calculated to be 36,000 cfs. The peak flow into Upper Baker was calculated to be 28,000 cfs. The regulated peaks of 146,000 cfs and 152,000 cfs at Concrete and Mount Vernon respectively would have been 182,000 cfs and 180,000 cfs if left unregulated (as estimated by the National Weather Service River Forecast Center's Skagit Basin Model). This represents a theoretical reduction in stage of 3.5 feet at Concrete and 4.5 feet at Mount Vernon.

17. Snohomish, November 21-26. The first flood warning bulletin for the Thanksgiving Day flood was issued 12:15 p.m. Wednesday November 21 and included the Skykomish and Snoqualmie Rivers. Four tenths of an inch of rain had already been measured at the Snoqualmie rain gage since 6:00 a.m. that morning. It was to become more intense for the next 24 hours, slacken off a bit, and then early on the 23rd beginning at 5:00 a.m. become much more intense with 9 inches of rain falling in the next 34-hour period. Reflecting the precipitation pattern, streamflows in the Snohomish, Snoqualmie and Skykomish basins experienced an early peak, a slight turn down, and then a renewed rise to a record peak flow before receding steadily.

a. Skykomish. Beginning early on November 22 the Skykomish River at Gold Bar rose very sharply in its characteristic way. The rate of rise decreased and the river had a preliminarily peak of 14.4 feet before receding to 13.2 feet. A second major rise began a little after noon on November 23 and didn't stop until the stage reached 22.49 feet at 7:00 a.m. November 24. The peak discharge of 101,600 cfs was a flood of record for the period 1928-1991, and was rated as a 33-year event. The stage was above major damage from 11:00 p.m. November 23 until 1:00 a.m. November 25 and above zero damage from 8:00 p.m. November 23 until 9:00 a.m. on November 25.

b. North, Middle, and South Forks Snoqualmie. The Middle Fork Snoqualmie River Near Tanner experienced a peak flow of 30,100 cfs at 3:15 p.m. November 24 which fell just below the period of record maximum flow of 30,200 cfs from 1977. The return period is 20 years. The North Fork Snoqualmie River Near Snoqualmie Falls reached its peak discharge of 12,000 cfs by 9:00 a.m. November 24 which fell somewhat short of the record flow of 15,800 cfs. The corresponding return period on the North Fork was 8 years. The South Fork Near Garcia reached 8,000 cfs at 2:15 a.m. November 24 equating to a 50-year event. Downstream at Edgewick it reached a peak discharge of 9,750 cfs at 6:15 a.m. November 24. The Snoqualmie River Near Snoqualmie gage malfunctioned before the peak. The maximum recorded stage was 19.33 feet for 47,925 cfs but the river may have reached 21.1 feet as indicated by a high water mark.

c. Raging River. The Raging River set yet another flood flow record with a discharge 5,540 cfs. The Raging River has had four floods of record since 1980. Prior to that year the flood of record was 3,430 cfs and had stood since 1951. Since 1976 there have been eight peak flood flows in excess of 3,300 cfs. The issue paper entitled "Forestry Practices and Flood Levels" put out by King County Surface Water Management Division suggests that runoff characteristics in the basin may have been changing in the past two decades. It is also possible that parts of western Washington have been experiencing a trend toward heavier rainfall (i.e. wetter) conditions during that same time period.

d. Tolt River. Around 2:00 a.m. November 24 the South Fork Tolt River Near Index had a peak discharge of 1,180 cfs. The elevation on Tolt Reservoir crested at 1,765.98 feet on the 24th at 4:00 p.m. and had a corresponding estimated discharge of 3,400 cfs. Downstream of the reservoir the South Fork Tolt River Near Carnation reached a discharge of 5,380 cfs at 6:30 p.m. on November 24. On the North Fork Tolt River Near Carnation the discharge reached a maximum flow of 7,330 cfs by 9:00 a.m. on November 24. The main stem of the Tolt River near Carnation had a peak "regulated" discharge of 11,200 cfs with a corresponding return period of 14 years.

e. Carnation. The Snoqualmie River Near Carnation gage went from 48 feet at 6:00 a.m. to zero damage stage of 54 feet by midnight on November 22. It leveled off at 55 feet for 10 hours between noon and 10:00 p.m. on the 23rd and then rose above major damage level of 54 feet by 10:00 a.m. on the 24th and on to a peak stage of 60.61 feet by midnight on the 24th. The stage receded steadily back down to major damage by 9:00 p.m. on the 25th and down past zero damage by 3:00 p.m. on the 26th. The peak discharge was 73,100 cfs and had a return period of 50 years.

f. Monroe. The Snohomish River responded in kind to all the high inflows upstream. At the gage near Monroe the river began to rise early on November 22 and was up to zero damage elevation by 9:00 p.m. that evening. During most of the 23rd the stages lingered just above 15 feet. Late on the 23rd the discharge began to increase and continued to rise until 6:00 a.m. November 25 when it reached a peak stage of 25.42 feet (with an 80-year recurrence interval) and had a peak discharge estimated at 135,500 cfs. The stage was above major damage elevation 17 feet from 3:00 a.m. November 24 until 1:00 p.m. on November 26. It receded below zero damage by 1:00 a.m. November 27.

g. Snohomish. The Snohomish River gage near Snohomish followed a similar pattern set at the Monroe gage but lagged behind it by about 4 hours. The Snohomish gage went past zero damage by 1:00 a.m. on the 23rd and past major damage by 7:00 a.m. on the 24th. The peak stage of 33.33 feet occurred at 11:00 a.m. on November 25. The estimated discharge and return period were 165,000 cfs and 80 years respectively. The stage fell below major damage by 8:00 a.m. on the 26th and was below zero damage by late afternoon on November 27.

## FLOOD DAMAGES

18. General. Total flood damages from the November 9-12 and 21-26, 1990 flood events for the Nooksack, Skagit, and Snohomish basins have been estimated to be about \$80 million. The Forest Service has also reported damages in the Mt. Baker-Snoqualmie National Forest to be an additional \$20 million. In addition to damages in the United States, Canada has estimated damages of \$1.5 million, caused by flooding from the Nooksack River. Estimates of flood damages were obtained from various Federal agencies including FEMA, Soil Conservation Service, Agricultural Stabilization Service, Small Business Administration, National Flood Insurance Program, U.S. Forest Service, and the Corps of Engineers. Information was also obtained from county and city representatives, the Red Cross, newspapers, as well as field investigations during and after the flood events. Damage categories for this analysis are described below:

- a. Public Facilities. Public damages include inundation losses to state, county and city roads and bridges, schools, public facilities, local parks and utilities.
- b. Flood Protective Works. Includes estimated costs to repair levees and erosion to streambanks.
- c. Agriculture. Damages include crop loss, replanting costs, sediment & debris removal, erosion, and physical damage to machinery & structures.
- d. Residential. Includes damage to residential structures, contents and grounds.
- e. Emergency Aid. This category includes temporary shelter, evacuations, flood fighting costs.
- f. Other. Represents miscellaneous damages including traffic delays, and damage to commercial property (physical damages and business losses) and automobiles.

19. Nooksack River Basin. On the Nooksack River, the 9-12 November flood was estimated to be a 11-year event at Deming, while the 21-26 November flood had a recurrence interval of 6 years at the same location. Between November 10-13 over 17,000 acre-feet of water flowed into Canada from the Sumas basin. The TransCanada highway was flooded for about 26 hours. Canada has reported damages caused by Nooksack overflow to Sumas Prairie of \$1.5 million from damages to infrastructure and private residences. Within the United States, the city of Sumas has reported the most significant damages estimated at \$5.2 million. A detailed estimate of these damages is available in Economics Section. The cities of Everson, Nooksack, and Marietta were also heavily

impacted. A summary of damages follows. Note that damages listed under flood protective works includes \$2.9 million for levees and \$4.7 million for stream bank erosion.

| <u>Category</u>                          | <u>Damages</u>   |
|------------------------------------------|------------------|
| Public Facilities                        | \$3,000,000      |
| Flood Protective Work<br>(COE \$873,000) | 7,600,000        |
| Agriculture                              | 2,000,000        |
| Residential                              | 3,600,000        |
| Emergency Aid<br>(COE \$159,000)         | 1,100,000        |
| Other                                    | <u>4,300,000</u> |
| Total                                    | \$21,600,000     |

20. Skagit River Basin. The November 9-12 flood was estimated to be a 17-year event at Mount Vernon. The recurrence interval of the November 21-26 event was 40 years at the same location. The area hardest hit by flood waters was Fir Island where a major levee failed during the first event. The failure inundated 8,000 acres of agricultural land and destroyed 50 residential and farm structures. Damages in this area alone are estimated to be at least \$7,000,000. Other cities within the basin reporting significant damage included Mount Vernon, Sedro-Woolley, Burlington, Hamilton, Concrete, and Lyman. The following table summarizes total damages.

| <u>Category</u>                             | <u>Damages</u>      |
|---------------------------------------------|---------------------|
| Public Facilities                           | \$ 6,500,000        |
| Flood Protective Works<br>(COE \$4,400,000) | 7,500,000           |
| Agriculture                                 | 11,200,000          |
| Residential                                 | 7,600,000           |
| Emergency Aid<br>(COE \$630,000)            | 1,100,000           |
| Other                                       | <u>\$ 3,300,000</u> |
| Total                                       | \$37,200,000        |

21. Snohomish River Basin. Flood damages were estimated only for those losses incurred in the Snohomish County portion of the Snohomish River Basin. Levee failures on Ebey Island and

Marshland contributed significantly to damages. The first flood event on the Snohomish River was estimated to be a 15-year event at Monroe, while the Thanksgiving Day weekend flood had a recurrence interval of 80 years. The following table summarizes total damages.

| <u>Category</u>                           | <u>Damages</u>          |
|-------------------------------------------|-------------------------|
| Public Facilities                         | \$ 5,000,000            |
| Flood Protective Works<br>(COE \$337,000) | 5,200,000 <sup>1/</sup> |
| Agriculture                               | 2,900,000               |
| Residential                               | 4,000,000               |
| Emergency Aid<br>(COE \$110,000)          | 2,300,000               |
| Other                                     | <u>\$ 1,900,000</u>     |
| Total                                     | \$21,300,000            |

<sup>1/</sup> Preliminary estimate

22. Damages Prevented by Operation of Flood Control Projects. The total damages prevented by operation of flood control projects by Seattle District (Ross, Baker, Mud Mountain, Howard Hanson, and Wynoochee) for both events totalled \$477,300,000. Projects in the Skagit basin include Ross and Baker. During the November 9-12 flood these projects prevented \$169 million in damages. For the 21-26 November event, flood control regulation prevented an additional \$98 million in damages.

23. Additional Reading and Information Sources. Information concerning the data and documentation in this report can be obtained from the Department of the Army, Seattle District Corps of Engineers, P.O. Box 3755, Seattle, WA 98124-2255. Other good sources of information are:

Skagit River Valley, The Disaster Waiting to Happen, Larry J. Kunzler May 1991.

Flooding of West Sumas Prairie, November 9-12, 1990, Kohn Leonoff Consulting Engineers for BC Environment, Water Management, 9 April 1991.



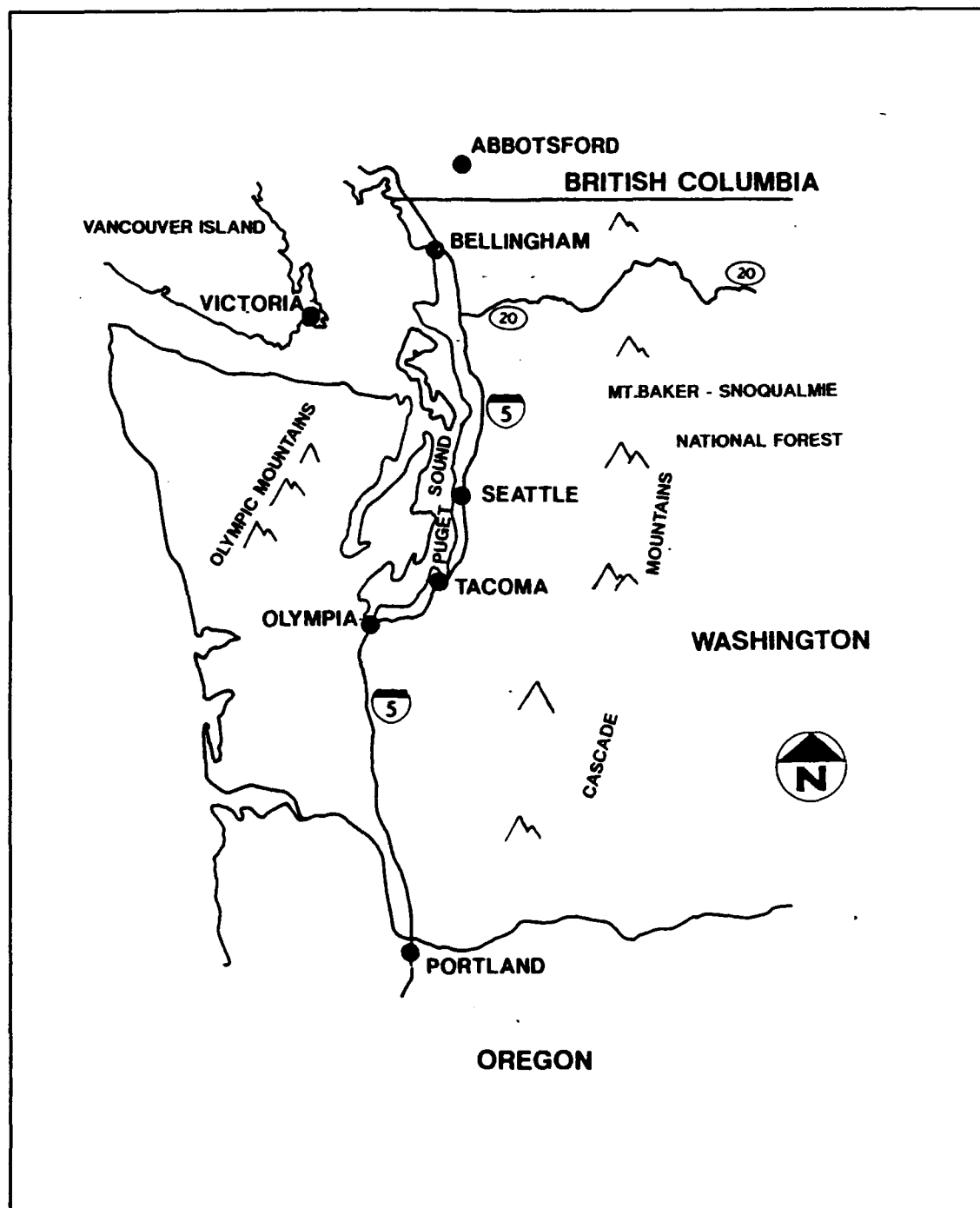


Plate 1. Vicinity Map



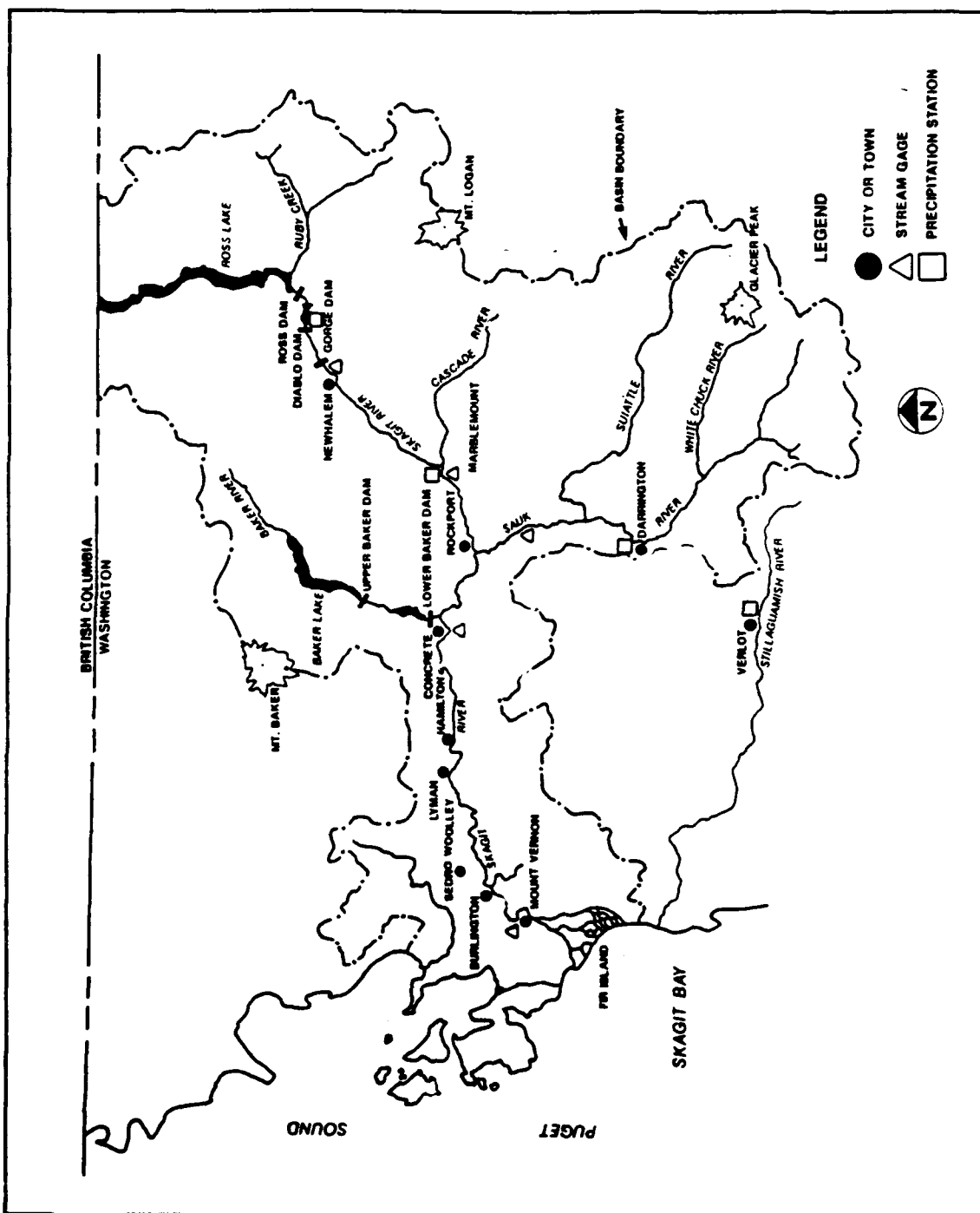
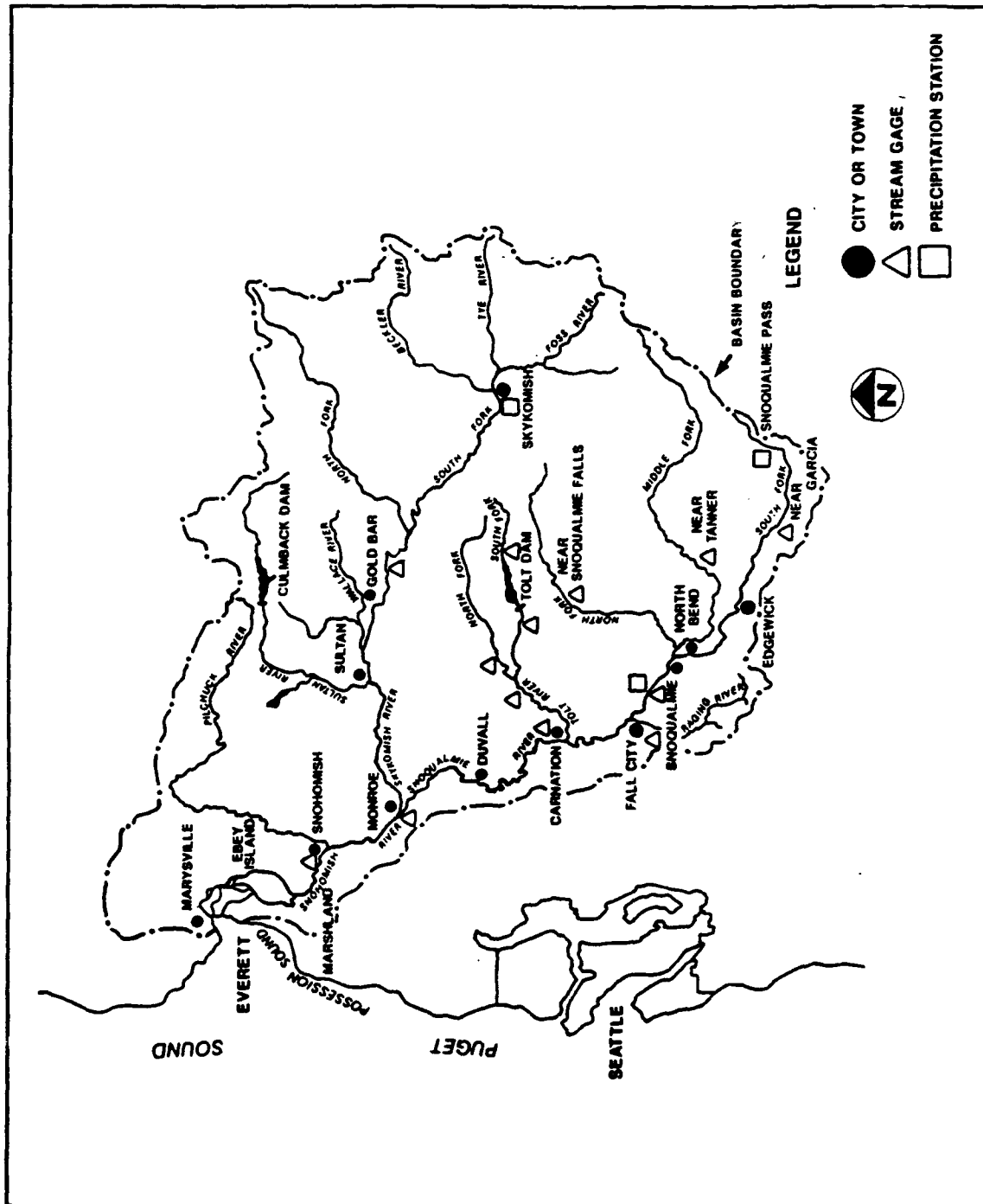


Plate 3. Skagit River Basin Map



### Plate 4. Snohomish River Basin Map

## APPENDIX A

### Flood Fight Reports, 9-12 November Flood

CENPS-CO-FL

MEMORANDUM FOR CH, Emergency Management Branch

SUBJECT: Flood Fight Report, Nooksack River Basin, 9-14 November 1990

1. This flood fight report is submitted in accordance with paragraph 4.3a(2)(b) of the NPS Supplement to ER 500-1-1, dated 30 August 1985.

2. The Nooksack River Flood Team was mobilized 9 November and worked through November 1990 as the river rose to 3.6 feet above flood stage (12.0 feet at Deming) after record rainfall, record high temperatures, and snow melt. The river crested at 15.28 feet at 0930, 9 November 1990, and remained above flood stage for approximately hours. The peak reading at the Ferndale gage was 15.6 feet at 1130 hrs on 10 November 1990. The peak discharge at Deming reached cfs which ranks historically (since 1908) as reported by the Whatcom County Engineer. A complete list of river gage reading is attached as enclosure 1.

3. The following Corps of Engineers employees were engaged in flood fighting activities:

|                             |                       |
|-----------------------------|-----------------------|
| Anill Berg                  | Flood Engineer        |
| Kelly Bingham               | Asst. Sector Engineer |
| Connie Bifer                | Contract Specialist   |
| Elaine Ebert                | Contract Specialist   |
| Joyce Ehrmantrout           | Administrative Asst.  |
| Robert Ehrmantrout          | Intelligence Chief    |
| Melvin Jenkins              | Support - Supplies    |
| Paul Johnson                | Sector Engineer       |
| Glen Kato                   | Technical Chief       |
| Jack Kennedy                | Asst. Sector Engineer |
| Wayne Kutch                 | Sector Engineer       |
| Gretchen Martinsen-Sullivan | Administrative Chief  |
| Jeri Moshier                | Support - Supplies    |
| James Shrinde               | Asst. Sector Engineer |
| Eric Winters                | Operations Chief      |
| Timothy Shaw                |                       |
| Eugene Brown                |                       |
| Douglas Weber               |                       |
| David Fox                   |                       |
| Mary Mitton                 |                       |
| Elizabeth McCallen          |                       |
| Laurie Wilson               |                       |
| Mitchell MacGregor          |                       |

4. The following Corps of Engineers employees were in related activities:

|                 |                        |
|-----------------|------------------------|
| Kenneth Fellows | Emergency Mgmt. Branch |
| Robert Newbill  | Emergency Mgmt. Branch |
| Douglas Weber   | Emergency Mgmt. Branch |

5. The activities of the flood team included furnishing sandbags and geotechnical fabric; coordinating and directing sandbagging operations; hiring and directing equipment and operators (for temporary levee protections and to facilitate sandbagging operations); and providing technical advise and assistance. All flood team members performed exceptionally, with outstanding results. Whatcom County, Diking District No. 1, and the residents of Marietta were also actively involved in the flood fighting effort. Approximately sandbags were placed county wide by volunteer sandbaggers whose numbers exceeded individuals.

6. The following is a brief summary of the major activities undertaken during this flood fight in chronological order (more detailed information is provided in Enclosure 2):

a. 9 November 1990:

1. The flood fight team was mobilized on 9 Nov 90; flood headquarters were set up by 1400. An emergency meeting was held with Whatcom County at the County Shop at 1430. Dan Fitzgerald of Whatcom County EOC formally asked the Corps of Engineers for assistance at 1440. This information was relayed to Emergency Operations at the District Office at 1445 and the OK was given to mobilize all required flood team members.

2. Inspection of the Everson area showed that there was no sandbagging being done at the fire station. Watter was reported running over Main Street and Everson Road. The State Bridge was being threatened and Washington Street was flooding. 500 sandbags were left in Everson to assist in protecting businesses and private homes.

3. The levee overtopped at Mt. Baker School. Whatcom County EOC was informed at 1645 so that they could make arrangements to have school buses and equipment removed.

4. A sandbagging operation began in the town of Marietta at 2100. A request was made for 15000 sandbags, the light plant, and cristafulli pumps and 8 truckloads of sand. A loader, small cat. and four dump trucks were hired. Pit was hauled to build up the levee in order to make it more accessible for sandbagging operations. The Marietta effort continued throughout 10 Nov 90.

b. 10 November 1990:

1. Early on the 10th, a sandbagging operation was initiated along a 40 yard long section of the River Road. Boils and overtopping was reported along the bank of the river downstream of Ferndale. Corps personnel and volunteers conducted a sandbagging operation at the levee placed upstream of the area better known as the Harliss property.

2. Problems were reported and sand bagging requested at Ferndale Road (location better known as Neldas') at 1000. Access was not available through the regular route through Ferndale. The dike broke here at approximately 1856.

c. 11 November 1990:

1. On the east side of Chuckanut Drive a fire station and several houses were reported in danger. Water was piping around the existing road culvert (used to drain a deep depression behind an old railroad grade) and a sinkhole had appeared east of the road. There was 20 to 35 feet of water covering about 2 1/2 acres existing in the depression as of about 0300. The Corps, County representatives and an on-site contractor formulated a plan to place 50' of 36" culvert to alleviate the problem. The Department of Transportation was consulted. The culvert was placed and anchored with sandbags and backfill. The National Guard and Whatcom County Search and Rescue created a channel across the road with sandbags. Residents below the road were evacuated.

q. Tim Shaw was sent to Caccosa Motel to pick up 2 pumps and take to Chuckanut Drive at 2247. At 0103 on 11 Nov, Tim Shaw arrived at milepost 16 with 2 pumps. County will have crane in a.m. to clean out culvert. Sandbaggers rechanneled water around the Fire Station at 0130. The backhoe was also used to help channel water around the Fire Station. At 0330, fill was saturated and people evacuated.



SUBJECT: NOOKSACK FLOOD FY91

PERSONNEL: ERIC WINTERS

Eric Winters arrived Nooksack EOC at 1345 and set up base, including phones, maps and admin office.

Paul Johnson arrived at 1430 and left for emergency meeting with Whatcom County at the county shop. Wayne Kutch arrived at 1435 and left for Everson to inspect flooding.

Phoned Dan Fitzgerald at Whatcom County EOC at 1440 and he verbally asked the Army Corps of Engineers for assistance and gave flood information.

Spoke to Paul Komoroske at 1445 and informed him of the Whatcom County request. He said to call all the flood team members required.

Jim Skrinde arrived at 1550 and left for the Coast Guard.

Wayne Kutch phoned in at 1615 and reported no sandbagging being done at fire station. Main Street has 6" of water running. Everson Road under water and not passible. Washington Street has 8-10" of water. State bridge at Everson is being threatened - the state will wait for another foot of water before shutting the bridge down.

Paul Johnson phoned at 1645 that the levee overtopped at Mt Baker School. Eric Winters phoned Whatcom Co. EOC and informed them they needed someone to evacuate school buses and equipment from their shop. The county EOC will respond to remove buses.

Wayne Kutch phoned at 1700 to report that Washington Street would require too many sandbags. Jerry McDowell informed Wayne that when Washington Street was resurfaced the road surface was taken down 12" for a flood way. Wayne dropped off 500 sandbags to Everson, protecting businesses and private homes.

Arill Berg reported at 1710 that Marietta needed 15000 sandbags, light plant and christafolli pumps. Mt. Rescue has 10 sandbaggers and needs 10000 bags to start plus 8 truckloads of sand. The brush needs to be flattened and gravel dumped. The Mt. Rescue will start with a double row of bags across the road.

Paul Johnson reported at 1815 that Avet Road was closed for 1 mile - houses being sandbagged, Nooksack levee being overtopped.

Wayne Kutch and Jim Skrinde reported the bridge at Everson main road has debris piling up. Arill Berg reported water over River Road.

Robert Ehrmantrout arrived at 2000 and was informed of the office operation. Eric Winters then left office to help Paul Johnson in Marietta for sandbagging and equipment.

450 JD and dump trucks arrived at 2300 to work on the downstream side in Marietta on Marine Drive. Bobcat arrived for moving sandbags, also using local 4x4 trucks for moving bags. Sandbagging being done on Marietta dike across Marine Drive and Country Lane. Winters closed Marine Drive at 2450. The bagging was 4 bags at base, 3, 2, and 1 for 350'. Presently, over 1800 feet of diking being sandbagged with an estimated 20000 bags used. One 450 dozer and 4 dump trucks working on the dike. Three Corps personnel (Winters, Kato, Johnson), 50 sandbaggers being rotated by Search and Rescue. Received 8 truck loads of sand.

Request was made at 0800 for a 590 TD excavator to clear levee top for sandbagging and placing gravel. Sandbaggers are able to keep up with the water coming up, even though the high tide was at 1300. Heavy equipment working well. Filter fabric being used with siper gravel -- approximately 125 feet being presently worked along with 6 truck loads of sand.

At 1730, sandbagging was halted due to water overflowing between the heavy equipment job and sandbagging job. The county was advised to start evacuating Marietta. Removed lights and prepared for transport. Winters left Marietta for Ferndale and the break in levee at Nelda's farm. An 80 foot break is being closed with rock and sandbags. Winters signed off at 2315.

SUBJECT: NOOKSACK FLOOD FIGHT, 10-11 NOV ACTIVITIES

PERSONNEL: JIM SKRINDE

I departed Nooksack Base at 1530, 10 Nov, for Everson where I briefly assisted with sandbagging activities. I observed a logjam against the right bank approach span of the Everson Bridge at RM 23.2. I discussed my concerns with Darrell Bush, WSDOT. I responded to a request for assistance at a house, address 1608 Ruttsatt Road near Van Zandt. A 200 ft. long piece of levee had failed and a trailer house was threatened with inundation. I assisted in sandbagging the house and departed.

At 0400, 11 Nov, I traveled to River Road where sandbagging operation had begun on a 400 yard long section of levee at RM 13.5. The levee there is very sandy and numerous boils appeared. The boils were ring diked. Sandbagging continued until water flowing in behind the levee from Fishtrap Creek inundated access roads. Levee reconnaissance ended when the adjacent farms finished evacuating livestock. Sandbagging also occurred upstream of this Guide Meridian Bridge. However, the levees are largely unmaintained upstream of the bridge, and overtopping was widespread. Flood fighting attempts ceased when the residents evacuated their homes.

At 0930, I drove to the Harliss farm at RM 3.3. Overtopping over a 1/2 mile section of levee was occurring. Sandbagging operations commenced at 1100. The levee was sufficiently raised to contain the river to the Slater Road Bridge by 1500. A large boil appeared in the levee placed upstream of Harliss during the Nov 89 flood fight. The boil was ring diked.

At 1600, I traveled to Hovander's farm at Rainbow Slough. Overtopping was occurring on a 500 yard section. I assisted in starting a sandbagging operation and remained until I was relieved by Wayne Kutch at 1700.

SUBJECT: FLOOD FIGHT ON RIGHT BANK NOOKSACK DOWNSTREAM OF SEWAGE TREATMENT PLANT AT FERNDALE (NELDA'S)

PERSONNEL: DOUG WEBER, DAVE FOX, GENE BROWN, TIM SHAW AND ERIC WINTERS

Doug Weber and Dave Fox arrived at the levee breach approximately 2000. The breach was 4' deep and 40' wide. The locals were attempting to close the break with rock and sandbags. We were able to slow the flow down using class III riprap and then build a ring dike around the road with sandbags. The closure was complete at 2300.

The riprap, sand and bags were provided by the county. Two tractors and a loader were supplied by local farmers. Approximately 40 volunteer sandbaggers helped to close the breach.

Eric Winters provided a Corps owned light plant. This was the only piece of equipment supplied by the Corps.

Dave Fox, Gene Brown and Doug Weber watched the closure closely until 0230 when the water started to recede.

SUBJECT: FLOOD FIGHT, CHUCKANUT DRIVE - MILEPOST 16 - FIRE STATION

PERSONNEL: DOUG WEBER, GENE BROWN, TIM SHAW AND DOUG FOX (REPORTING)

Doug Weber, Gene Brown and David Fox left Nooksack floodfighting efforts at Nelda's at approximately 0230. We were directed by Mitch MacGregor to Chuckanut Drive, Milepost 16 where a fire station and several houses were reported in danger. We met Tim Shaw at the scene.

The situation was as follows: The fire station is located on the eastside of Chuckanut Drive. Above the station, and running parallel to Chuckanut Drive, is an old railroad grade, the Interurban Line. The fill for the grade was approximately forty feet in height. A culvert (approximately 3') runs through the fill at its base. The culvert drains a deep depression behind the grade. From this culvert, water normally flows down a floodway to Chuckanut Drive where it flows beneath the road through another culvert (approximately 3'). Both of these culverts were checked with silt and very little flow was moving through them. Water was piping around the road culvert and a sinkhole had appeared east of the road. A private driveway traversed the Interurban grade and led to a house on a hill above the grade. Water was ponding in the depression between the grade and the hill just to the north and east of the house. The source of the water was a cascade of relatively high volume which was raising the water level in the depression at an estimated rate of approximately 18" per hour. We were told that 20 to 35 feet of water (at the deepest), covering about 2 1/2 acres existed in the depression as of about 0300.

We proceeded to the base of the grade, to the roadward end of the grade culvert. The culvert was silted shut. The material at the base of the grade was saturated and spongy. We could hear trees toppling above and quickly evacuated the immediate area, fearing a catastrophic failure of the grade.

A plan was formulated between the Corps, a contractor who was on site (N. Jim Hutson - 671-2179) and county representatives. To prevent further accumulation of water behind the grade and the possibility of catastrophic failure, it was decided to place 50' of culvert (36'), sloping down across the private driveway which would reduce the head above the grade and direct the water to the other side of the driveway, past the fire station, over Chuckanut Drive and back into its normal drainage. The idea was to avoid ponding water behind the blocked culvert beneath the road which would increase the piping and take out the road.

The Dept. of Transportation was called to the scene. The representative (Jim McDonald 739-0548 or 676-2100) was not concerned about ponding behind the road so a plan to block a 12" culvert which ran under the private drive was abandoned.

At daybreak (approximately 0645) we checked the condition of the project. Water was flowing around the south side of the fill over the road culvert. A water main, telephone line and fiber optic cable were exposed by the scours. A backhoe was used to reroute the water to the west of Chuckanut Drive. This was successful but scour of the utility trench continued. The 12" culvert was finally blocked and water flow was decreased to the area behind the road culvert but not before piping had scoured large quantities of material from under the road. The road was in danger of collapse.

All the residents below the road had been evacuated between 0300 and 0400. We were ordered to evacuate by a U.S. Ranger. The situation had stabilized by this time and we left at approximately 0730.

PERSONNEL: PAUL JOHNSON

Sandbagging operations in the town of Marietta began at 1500 on 9 Nov. Residents initiated the sandbagging operations and closed off the drainage culvert which runs under Marine Drive at the intersection of Marine Drive and Country Lane. The culvert was sealed with plywood and sandbags. Sandbag operations continued through 10 Nov and was stopped at 1900. Activities were halted because of general overtopping behind residential houses which were inaccessible because of thick brush and trees. A Bobcat loader was hired to transport sandbags along the levee.

A John Deere 450 cat began clearing the levee along Marine Drive. Operations began near the river boat access and proceeded toward the town of Marietta. Four trucks were hired to bring in dirty pit run material from the Siper pit. The pit run was placed over a geotextile fabric. On 10 Nov, at 1130 a John Deere 590 excavator began removing brush and trees along the levee. The majority of the levee was cleared. There was a 500-1000 foot section that was inaccessible because of high water and poor levee conditions. It was this area where overtopping took place and caused all flood fighting operations to cease.

The contractor cut a trench diagonally across the drive, placed the 35" culvert in and anchored it with sandbags and backfill. Plastic was placed along the intended path of water both above and below the culvert to prevent scour. A backhoe was used to pile soil along the driveway to keep the water flowing on the south side of the driveway away from the road culvert. The National Guard and Whatcom County Search and Rescue created a channel across the road with sandbags.

Water was diverted through the culvert above, down a ditch on the south side of the driveway, through the sandbag channel and across the road. Flow started at approximately 0530. The plan worked except for some minor scour around the northeast corner of the fire station.

Flow increased at about 0600 and started coming around the south side of the station. Water also continued through the 12" culvert under the driveway and piped under the road along the 36" culvert.

SUBJECT: FLOOD FIGHT ACTIVITY SUMMARY, 9-10 NOV 90

PERSONNEL: WAYNE KUTCH

1430 arrived EOC - proceeded to Everson for reconnaissance. Met with Fire Chief, Jerry McDowell, at Everson Fire Station, which functions as the local EOC during flooding. Water was already flowing down Main Street (approximately 6" deep at 1600-1700). A sandbag filling operation had been set up at the end of First Street. Discussed the possibility of flood fighting with Jerry. He indicated that this would be futile since water comes from too many locations there. Instead, businesses and residences were being sandbagged where necessary. Met with state employees regarding deris impact against timber bent on bridge. They did not feel this was a serious hazard.

Next, proceeded to River Road downside of Guide Meridian Bridge - right bank. Water approximately 6" deep near downside of road. Levees in good condition (approximately 2000-2200).

Received call regarding private residence near Deming - a levee break being threatened. Levee break turned out to have occurred last year but never fixed. House located on Rutsadt Road. Sandbagging was in progress using 6-8 neighbors. There appeared to be no immediate threat to the house (due to the sandbag effort). Water was only about 3" deep at only side of house. It was reaching sandbags. Advised the owner to contact us if additional assistance required.

Went back to River Road (0200) to check on levees. Locals had begun placing sandbags on back side of levee to stabilize spongy soil. Water was at top of levees across several residences at RM 14.5. Began ringing bells when necessary and raising top of levee with double row of sandbags. Effort continued until 0900. However, overtopped levees along Fishtrap Creek were causing backflooding and causing effort to be abandoned.

Proceeded to Ferndale (1000) along Ferndale Road. Road was topped at treatment plant. City was placing sand and using grader to move where needed. Additional sandbagging underway at Sigurdson and Anderson residences (across Ferndale Road). Was asked to try to allocate trucks to various efforts. Major effort was underway at Harliss farm. Asked for 4-5 trucks sand/gravel to supplement city efforts at treatment plant when they appeared to be losing ground. Also, 8 loads of pit run for Sigurdson effort for ballast against back of levee.

Relieved Skrinde at Rainbow Slough at Ferndale Road at approximately 1700. Entire length of new levee along Slough being topped starting from 500' west of Ferndale Road. Advised EOC that this would require major effort to save (100 sandbaggers + equipment). Topping was at least 6-8 inches in some areas with back of levee being eroded. EOC indicated they would see if they could locate sandbaggers.

While waiting for word on sandbaggers (0730), advised of break at Sigurdson's. Decision was made to abandon effort at Rainbow Slough. Eleven members of Air National Guard arrived for labor assistance. Showed them break at Sigurdson and ended shift.

SUBJECT:

PERSONNEL:

About 0830, reports were received about overtopping of the levee downstream of Harliss farm.

Kennedy on scene 0840, walked the levee. Overtopping occurring in a 400 yard section, about 6" deep, in 4 locations about 150 feet long and 3 other 20-40 feet long. Overtopping occurring also upstream of Harliss farm in a 35 foot sections. One row of bags was already laid by locals.

Skrinde on scene 0930 - walked to scene on levee. We ordered 2 trucks of sand and baggers.

Bangham on scene 0950 - walked upstream and downstream overtoppings by Harliss farm. Overtopping also occurring downstream of bridge by Harliss farm in a 35 foot section, 6" deep.

Berg on scene 1015 - Berg and Bangham bagging from upstream at Harliss section began at 1030. Sand appeared 1045, as did about 6 volunteers. Bagging operation began at "Kutch's Pad", gravel placed in 1999 flood.

Placed single layers of bags at first upstream break downstream of Harliss'. Bags were delivered by a small tractor along top of dike and by Hovander's tractor. Two Corps people, 1 volunteer placed.

Hovander's large 8-wheeled tractor, traversing the fields delivered sandbags to second break, 150' long, 1 1/4' deep. Backside of dike showing serious erosion. This entire section of dike was well built with grass and berry plants helping to slow down erosion - 2 Corps baggers, 2 volunteers.

1200 - Most serious overtopping, 1 1/4' deep. This occurred toward middle section between Harliss farm and bridge. Two Corps employees, 1 volunteer and the 8-wheeled tractor laid two rows of bags to divert flow around section with worst erosion and highest flow. We later reinforced the bottom layer of bags with a second row. Some sandbags were delivered by a small boat coming from the Slater Road Bridge.

1300 - Berg, Skrinde, Kennedy leave. Twelve volunteers at high point. Serious lack of communication tie to base and no transportation left for Bangham. No access to order bags and sandbaggers. (Bags being supplied by Hovander's farm, primarily). Placed 1 row of bags along entire section of levee between Harliss farm and second gate before bridge. Reinforced heavy flow areas with second layers of bags and tried to control general overtopping along section.

Area at center between Harliss and bridge eroded heavily from both sides, likely break area if continued rise in water level.

1500 - Berg arrives at bridge. Discussed situation and split group of 5-8 volunteers along levee and downstream of bridge to control overtopping in both locations. Lack of bags and sand.

1600 - 950 top loader arrives at Harliss'. Machine is too heavy to work a center section of levee. He couldn't drive through fields without getting bogged down in water/mud. Released him from this job (1640).

Continued operation with bobcat alone, 6 volunteers, 1 Corps personnel. Harliss brings in his other tractor - 1700.

Area downstream of bridge is no longer overtopping. River has dropped 1" by 1730. Breakout possibility questioned. Returned workers to maintain Harliss levee overtopping. Freeboard is maintained at 1/2" - 4".

Volunteer team functioning well. Harliss tractor and bobcat remain to assist team. At 1800 Corps personnel leaves site to go to Rainbow Slough. Levee was holding up all right.

This effort was helped very much by the levee condition and machinery which delivered sandbags. It was greatly hampered by a lack of coordination (communication) with base, transportation and sand delivery. Thirty to forty volunteers with Corps direction could have finished it up in 2 hours.

SUBJECT: ACTIVITY REPORT - NOOKSACK FLOOD FIGHT

PERSONNEL: WAYNE KUTCH

At 1100-1300, inspected work area at Chuckanut Drive (Mile 16). New 36" culvert had been installed above Chuckanut Drive early this morning. Existing culvert which drained area behind railroad grade was plugged causing 30'+ deep "lake" to form. Concern over stability of embankment lead to decision to try to drain lake rather than stop flow by building up embankment. Flow had caused erosion on downhill side of Chuckanut Drive - 2 phone cable conduits, 1 fiber optic cable were exposed. A large (10' x 6' deep) sinkhole had formed on the U.S. side of Chuckanut sometime prior to the arrival of COE personnel. The sinkhole indicates probable piping of material from the road embankment - possibly along the culvert through the road embankment.

Met with representatives of county (Dan Fitzgerald, Marlin Hansen), State Highway Dept, and various local authorities at county EOC regarding situation at Chuckanut Drive (1300-1400). Decision was made to proceed immediately with work to reduce water level.

Returned to Chuckanut Drive work site at 1400 with county engineer Marlin Hansen. Inspection of backside of embankment indicated that it was in good condition (no visible piping or seepage). New 36" culvert was unsupported for 5' at downstream end, due to erosion from pipe outlet. Installed cable sling for temporary support. Lake level was decreasing at 1/2" per hour. Appeared to be no imminent threat (residences had been advised to evacuate earlier) and condition stable so decided to station observers and proceed with repair in a.m.

Returned to base station at 1800-2400. Arranged to meet with personnel from D.O. with pumps for work in a.m.

19 MARCH 1991

MEMORANDUM THRU Executive Office

For Chief, Operations Division

Subject: Floodfight Report, Skagit River Basin

1. Flood headquarters were established at the Skagit County Bayview Airport at 1800 hours on 9 November 1990 per the request of Skagit County Flood Engineer Don Nelson for assistance. The following Corps of Engineers personnel were involved in the flood fight:

|                 |                      |
|-----------------|----------------------|
| Ernie Sabo      | Flood Engineer       |
| Mark Ohlstrom   | Asst. Flood Engineer |
| Patty Cardinal  | Intelligence Officer |
| Jim Smith       | Sector Engineer      |
| Monte Kaiser    | Sector Engineer      |
| Ken Sanderguard | Sector Engineer      |
| Rick Eckerlin   | Sector Engineer      |
| Ben Lazo        | Sector Engineer      |
| Gene Brown      | Sector Engineer      |
| Joe Vasey       | Technical Adviser    |

2. The peak high water, at the Mount Vernon gage was reached at 1200 hours on 11 November. The stage, 35.20 ft., was 7 feet over flood stage with an approximate reoccurrence interval of twenty-five years.

The following is a brief description of significant events which occurred.

#### 9 November 1990

Base station was in operation by 1900 hours.

Between the hours of 2100 and 2300 a reconnaissance of the levee system was completed, finding no significant problems.

#### 10 November 1990

Several problem areas had developed by 0700 hours:

-Nookachamps and Dike District #20 were taking water, sand bag operation had begun on Francis road.

-Samish river basin, water over many roads and inundating several homes.

-By 1000 hours, residents of Cape Horn and Thunderbird Lane were being evacuated. Back-water from Jones and Alder Creeks were flowing over parts of SR 20.



- The city of Hamilton was inundated from flood waters of several creeks in area as well as the Skagit River.
- On Fir Island sandbag operations for several areas were planned.
- Potential problems also reported on the South Fork Moorage and Fisher Slough.
- In Dike District #9 a low level protection levee had been overtopped, water now backed up against Dodge Valley road. Berm and sandbagging taking place.
- Dike District #17, at big bend area, reported problems of a blocked culvert, which drained interior area.
- Revetment in downtown Mt. Vernon was overtopped. City and County were raising sandbags to 3ft. to protect city center.

The Concrete gage crested at 1300 hours at 38.2 ft, yet remained at that level for approximately ten hours. The Concrete gage typically peaks about a 12 hours prior to the Mt. Vernon gage.

#### 11 November 1990

- Levee break reported at Cockerham Island, several channels were being cut across island, a RR ballast was washed out on the north end.
- In Dike District #1 a berm was built across the state highway to prevent water from entering West Mt. Vernon. At the crest, at least 2ft. of water was up against the berm.
- Another problem area was at District Line Road and SR 20. Flood fighting was taking place at RR tracks, but work was overtopped by 0900. Further work had been started on SR 20 (at 0500) to build a berm on eastbound lane to prevent flood waters from entering Burlington.
- Several areas in Dike District #17 had been ring diked, seepage from river and interior drainage were causing problems. The water treatment plant had been sandbagged and was not reporting any problems.
- Sand bagging operations on Fir Island continued, there was a small levee break one mile upstream of N. Fork Bridge. Overtopping was reported at several locations some areas were evacuated.
- Major levee break occurred at the north end of Fir Island near Dry Slough at approximately 1400 hours. The Mt. Vernon gage had crested four hours earlier and was now at 35.05 ft. Within minutes, the break had reached an approximate length of 200 feet. The entire area was evacuated. Water from the breach would inundate all of Fir Island.

#### 12 November 1990

By 2200 hours on 11 November the stage at the Mt. Vernon gage was dropping approximately 0.3 ft/hr. However, close monitoring of all districts remained necessary due to heavy saturation of levees. North Fork levees were having the most serious problems with erosion on the landward (Fir Island) side.

Emergency repair operations for levee breaks on Fir Island and Cockerham were underway at this time.

13 November 1990

The Mt. Vernon gage dropped below flood stage at 2100.

A copy of the gage readings at Concrete and Mt. Vernon are enclosed, as are all flood fight reports.

Concrete Gage Reading:

| Time | 11/9 | 11/10 | 11/11 | 11/12 |
|------|------|-------|-------|-------|
| 0100 | -    | 35.6  | 37.48 | 30.66 |
| 0200 | -    | 36.0  | 36.83 | 30.65 |
| 0300 | -    | 36.5  | 36.46 | 30.61 |
| 0400 | -    | 36.9  | 35.34 | 30.44 |
| 0500 | -    | 37.1  | 34.86 | 30.34 |
| 0600 | -    | 37.5  | 34.51 | 30.29 |
| 0700 | -    | 37.7  | 34.10 | 30.23 |
| 0800 | -    | 38.0  | 33.66 | 30.0  |
| 0900 | 23.2 | 38.1  | 33.28 | 29.9  |
| 1000 | 24.2 | 38.1  | 32.80 | 29.84 |
| 1100 | 25.2 | 38.15 | 32.32 | 29.63 |
| 1200 | 26.5 | 38.15 | 32.18 | 29.5  |
| 1300 | 28.4 | 38.2  | 31.8  | 29.42 |
| 1400 | 29.6 | 38.16 | 31.54 | 29.3  |
| 1500 | 30.1 | 38.15 | 31.64 | -     |
| 1600 | 30.9 | 38.15 | 31.64 | -     |
| 1700 | 31.3 | 38.16 | 31.52 | -     |
| 1800 | 31.9 | 38.16 | 31.24 | -     |
| 1900 | 32.5 | 38.05 | 31.22 | 28.77 |
| 2000 | 33.2 | 38.05 | 31.0  | -     |
| 2100 | 33.6 | 38.06 | 30.9  | -     |
| 2200 | 34.1 | 38.07 | 30.7  | -     |
| 2300 | 34.6 | 38.07 | 30.7  | -     |
| 2400 | 35.1 | 38.04 | 30.6  | -     |

Mt. Vernon Gage Readings

| Time | 11/9 | 11/10 | 11/11 | 11/12 | 11/13 |
|------|------|-------|-------|-------|-------|
| 0100 | -    | 27.1  | 34.67 | 32.94 | -     |
| 0200 | -    | 27.5  | 34.77 | 32.63 | -     |
| 0300 | -    | 27.9  | 34.96 | 32.4  | -     |
| 0400 | -    | 28.3  | 35.06 | 32.15 | -     |
| 0500 | -    | 28.6  | 35.14 | 31.88 | -     |
| 0600 | -    | 29.0  | 35.15 | 31.64 | -     |
| 0700 | -    | 29.2  | 35.18 | 31.4  | -     |
| 0800 | -    | 29.5  | 35.17 | 31.22 | -     |
| 0900 | 16.8 | 29.6  | 35.18 | 31.01 | -     |
| 1000 | -    | 29.6  | 35.18 | 30.84 | -     |
| 1100 | 19.4 | 30.53 | 35.18 | 30.68 | -     |
| 1200 | 20.0 | 30.53 | 35.20 | 30.47 | -     |
| 1300 | 20.7 | 31.03 | 35.15 | 30.34 | -     |
| 1400 | 21.3 | 31.50 | 35.05 | 30.18 | -     |
| 1500 | 22.0 | 31.97 | 34.83 | -     | -     |
| 1600 | 22.5 | 32.15 | 34.77 | -     | -     |
| 1700 | 23.5 | 32.81 | 34.77 | -     | -     |
| 1800 | 23.7 | 33.18 | 34.77 | -     | -     |
| 1900 | 24.2 | 33.57 | 34.61 | 29.5  | -     |
| 2000 | 24.7 | 33.91 | 34.3  | -     | -     |
| 2100 | 25.3 | 34.3  | 34.1  | -     | -     |
| 2200 | 25.8 | 34.52 | 33.8  | -     | -     |
| 2300 | 26.2 | 34.51 | 33.5  | -     | -     |
| 2400 | 26.7 | 34.51 | 33.3  | -     | -     |

4 December 1990

MEMORANDUM THRU Chief, Operations Division

FOR Chief, Emergency Management Branch

SUBJECT: Flood Fight, ~~513-11-11-11-11~~ Snohomish River Basin,  
Washington

1. A weather system from Hawaii brought rain, wind and warm weather to Western Washington causing area rivers to flood. At 0930 on 9 November 1990, the U.S. Weather Service predicted that the Snohomish River, at Snohomish, would crest at 32.0 feet, 5 feet above flood stage, by 0800 on 10 November 1990. With this information, a reconnaissance operation was initiated at 1030. The following personnel was dispatched to the Snohomish River:

|                 |                          |
|-----------------|--------------------------|
| Don Thompson    | Assistant Flood Engineer |
| Ginny Dierich   | Sector Engineer          |
| Noel Gilbrough  | Sector Engineer          |
| Norm Skjelbreia | Sector Engineer          |

Reconnaissance was initiated at 1300.

2. The following reconnaissance activities were conducted the evening of 9 November 1990:

a. In Sultan, flood water was observed up to the feed store at approximately 1600, and up to 3rd Street at approximately 2200. The Skykomish River at Index was to the elevation of Avenue "A", with a staff gauge reading of 3.5 feet above flood stage.

b. The Stillaguamish from Stanwood to Oso was observed.

c. Russ McCutchen (Flood Engineer) and Steve Erland (Assistant Sector Engineer) were dispatched to the Snohomish River the evening of 9 November 1990.

3. The following events occurred on 10 November 1990:

a. The dike at the Snohomish sewage lagoon near Highway 9 began overtopping at 0740.

b. Stanwood sounded siren to alert flood fighters at 0820. At 1125 water from the Stillaguamish River is reported in the town. Bridge over Irvine Slough was reported out at . Sand dike was built under Highway 532 and in town and kept major flooding out of town. Approximately 6500 sand bags and 200 volunteers assisted in the flood fighting effort.

c. At approximately 0500 the gauge reading at Index was 4.0 feet above flood stage. The sector engineer recommended placing

CENPS-EN-DB-CD

SUBJECT: Flood Fight, 9-16 November 1990, Snohomish River Basin, Washington

a ring dike around a group of boils. While placing the sandbags, additional boils appeared outside of the dike. The ring dike was enlarge to incorporate the additional boils, but additional boils began to appear outside this enlarge ring dike. The determination was made to discontinue sand bagging. The gauge reading at Index began dropping around 1000. At about 1600, Index reported that the river level had dropped and the boils had not caused additional problems.

d. Water was reported near overtopping at Highway 2 trestle on Ebby Island. Locals provided sandbaggers and material. Ring dikes were place around boils and sandbags were placed in low areas to prevent overtopping. Sandbags were also placed at Bob Johnson's farm.

e. The French Creek pump plant and drainage structure were observed at 1200. Pumps were off and structures were in good condition. Water began overtopping at approximately 2100. Access was by dump truck only. No breach was observed, but levee continued to be overtopped.

f. The following personnel was dispatched to the Snohomish River Basin on 10 November 1990:

|                |                           |
|----------------|---------------------------|
| Henry Birchard | Assistant Sector Engineer |
| Jill Gough     | Sector Engineer           |
| Steve Pierce   | Assistant Sector Engineer |
| Janet Maxson   | Contracting Specialist    |
| Sandy Thomas   | Contracting Specialist    |

4. The following events occurred on 11 November 1990:

a. The road access to the French Creek pump plant off of Tresti Road was reported to be washed out along with a low portion of the Old Snohomish Highway. Access to the downstream side of the drainage structure was impassible due to erosion along new drain tiles in the field of the Darlington's farm which caused the access road to the farm to washout. Access into the area was limited to trucks with high suspensions.

b. In the vicinity of Highway 2 bridge and Ebby Slough, overtopping of the levee began at 1030. At 1200, a breach in the levee occurred 500 feet downstream of Highway 2 bridge on the Ebby Slough side of the island. The breach was approximately 100 feet wide and 5 feet deep. A total of 2500 sandbags, 14 county dump trucks, and 45-50 volunteers, including those from the diking district, Lake Stevens and Snohomish fire fighters, and men and women from Indian Ridge Correctional Facility.

CENPS-EN-DB-CD

SUBJECT: Flood Fight, 9-16 November 1990, Snohomish River Basin, Washington

Construction of a gravel driving surface was begun at 1300. As evening approached two light plants were rented and delivered to the site. At low tide at 1900, people and equipment concentrated on fixing the breach. At 2200, the sandbag repair of the breach was completed. Sandbaggers continued to stockpile full sandbags until 2400.

5. The following events occurred on 12 November 1990:

a. At the request of Snohomish County, COE began efforts to restore access to homes isolated by flood damaged roads.

b. The Ebby Island levy was walked from the eastside of the causeway to Jackknife Bridge.

c. Continued work on providing access to the breach downstream of the causeway and to the low spots upstream from the causeway.

d. Started filling holes in Riverview Road in District 13 at 1700 using 10 dump trucks, and one 450 dozer. Filled erosion holes in the road using 4 to 8 inch spalls to provide access to the levee break at the downstream end of District 13. Snohomish county provided the material and a grader to clean logs and debris off the road. Started filling the break at 2400.

6. The following events occurred on 13 November 1990:

a. Started filling break in Thomle Road at 1500 using 10 dump trucks, one D-6 dozer and one compactor. Snohomish County furnished the material. Two additional dump trucks were hired.

b. Work continued to repair break in District 13. A vibratory compactor was hired to assist in the repair. Pitrun material placed in the break was the best material available from Snohomish County.

7. The following events occurred from 14 through 16 November 1990:

a. The repair work on the break was completed at approximately 1100 on 14 November. Equipment was moved upstream in District 13 to repair sections of the berm along Riverview Road that had eroded during the flood. Work in District 13 was completed on 16 November 1990 at 1200.

c. Laurie Wilson was dispatched to Snohomish River to assist with administration details on 14 November 1990.

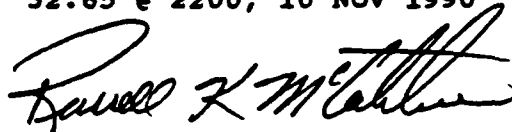
CENPS-EN-DB-CD

SUBJECT: Flood Fight, 9-16 November 1990, Snohomish River Basin,  
Washington

b. The Snohomish base station was closed at approximately  
1500 on 16 November 1990.

8. The following crests were observed:

| RIVER                  | ZERO DAMAGE | ACTUAL CREST              |
|------------------------|-------------|---------------------------|
| Skykomish @ Goldbar    | 15.0        | 20.89 @ 0300, 10 Nov 1990 |
| Snoqualmie @ Carnation | 54.0        | 59.42 @ 1200, 10 Nov 1990 |
| Snohomish @ Snohomish  | 25.0        | 32.65 @ 2200, 10 Nov 1990 |



RUSSELL K. MCCUTCHEN  
Flood Engineer

## APPENDIX B

### Flood Fight Reports, 21-26 November Flood



## NOOKSACK RIVER BASIN FLOOD FIGHT ACTIVITIES 24 - 30 NOV 1990

### MARIETTA

Worked with Whatcom County, Mountain Rescue, and volunteers to beef up sandbag levees that were built during the first event. A large area was overtopped during the first event and there was a break near Country Lane. We also excavated a small sump area and put in a Criste Fulli pump. Two would have reduced the water level but one maintained the level. The County paid for this operation.

### FERNDALE AND DIKING DISTRICT 1

The main event was the failure of the ring dike built at the Rayhorst Road break by the County with technical assistance from the Corps. The county built an access road from the north in hopes that they would be able to prevent failure of the ring dike. The flood engineer supervised an operation to build up the ring dike but access to the center of the ring dike was impossible due to the deep excavation on the landward side which made conditions unsafe for personnel and equipment.

The flood team was actively involved in patrolling the levees and supervising sandbagging operations from Ferndale to the Rayhorst Road break.

### DEMING ROAD RIVER CHANNEL

The flood team headquarters had had numerous calls from residents in the Deming Road area during both flood events but was unable to provide much assistance until the river had receded some. The problems in the area were discussed with the County Engineer and the Assistant Director of Public Works and it was decided that a joint effort by the County and the Corps of Engineers to close off the new channel that had cut into the farmland at the end of the Mariotta Road would be the most beneficial alternative of several discussed.

The work consisted of approximately 1500 feet of access road and about 1000 feet of temporary levee. The road was constructed of gravel pit run, quarry spalls, and geotechnical fabric. The levee section was constructed of 3 foot minus rock and existing river gravels.

The county provide two bulldozers, lights, a roller-compactor, and up to about 10 trucks. The Corps hired two light plants, the remaining trucks, paid for material, and provide project supervision. This operation was the only operation in which the Government hired equipment during this second event. The work began on the 25th and was completed on the 29th at a cost of approximately \$70,000.00.

The Soil Conservation Service stepped in at the completion of the Corps work to continue the bank protection effort with a \$1 million dollar contract which consisted of rock bank protection both upstream and downstream of the Corps project. I believe that the Corps effort led to a substantial benefit to the County in this area.

### CHUCKANUT DRIVE

The water level behind the chuckanut trail embankment had again risen to its previous level but the county had three pumps running and was able to reduce the water level after the rains subsided. The Corps continued to do spot inspections and to provide technical assistance until the situation was no longer a safety hazard.

19 March 1991

## MEMORANDUM THRU Executive Office

For Chief, Operations Division

Subject: Floodfight Report, Skagit River Basin  
22-26 November 1990

Work on an emergency temporary closure at the Fir Island levee break began on 13 November 1990; the operation continued (24 hrs/day) thru 22 November. The height of the closure at that time was approximately 25 ft. Due to forecasts for the Skagit River to again reach flood stage, Skagit County officials requested assistance from Corps flood fight personnel.

Personnel involved in the flood fight are as follows:

|                 |                      |
|-----------------|----------------------|
| Ernie Sabo      | Flood Engineer       |
| Mark Ohlstrom   | Asst. Flood Engineer |
| Patty Cardinal  | Intel. Officer       |
| Jim Smith       | Sector Engineer      |
| Monte Kaiser    | Sector Engineer      |
| Ken Sanderguard | Sector Engineer      |
| Rick Eckerlin   | Sector Engineer      |
| Ben Lazo        | Sector Engineer      |
| Gene Brown      | Sector Engineer      |
| Joe Vasey       | Technical Adviser    |
| Eric Winters    | Equipment Specialist |
| Jack Kennedy    | Sector Engineer      |
| Steve Hansen    | Sector Engineer      |
| Rick Moshier    | Sector Engineer      |
| Dave Moses      | Portland District    |
| Jerome Simpson  | Portland District    |
| Mark Dasso      | Portland District    |
| John Todd       | Portland District    |

The following is a brief description of significant events which occurred.

22 November 1990

A reconnaissance team assisted in further raising the Fir Island closure. Repairs were also started at the Cockerham Island levee break.

23 November 1990

Work continued on Fir Island, the job at Cockerham was stopped at 1600 hours due to rapidly rising water.

GAGE READINGS: CONCRETE AND MT. VERNON

| Time | 22 November |       | 23 November |       | 24 November |       |
|------|-------------|-------|-------------|-------|-------------|-------|
|      | Con / MtV   |       | Con / MtV   |       | Con / MtV   |       |
| 0100 | 22.30       | 19.71 | 27.24       | 25.62 | 33.90       | 28.80 |
| 0200 | 22.36       | 19.76 | 27.40       | 25.84 | 34.60       | 28.90 |
| 0300 | 22.41       | 19.81 | 27.62       | 25.95 | 35.30       | 29.20 |
| 0400 | 22.64       | 19.87 | 27.98       | 26.14 | 35.07       | 29.30 |
| 0500 | 22.82       | 19.94 | 28.12       | 26.30 | 36.60       | 29.50 |
| 0600 | 23.10       | 20.02 | 28.28       | 26.45 | 36.82       | 29.78 |
| 0700 | 23.49       | 20.14 | 28.52       | 26.59 | -           | -     |
| 0800 | 23.85       | 20.32 | 28.50       | 26.79 | 37.71       | 30.49 |
| 0900 | 24.24       | 20.52 | 28.42       | 26.95 | 38.00       | 30.81 |
| 1000 | 25.01       | 20.84 | 28.50       | 27.10 | 38.10       | 31.12 |
| 1100 | 25.47       | 21.16 | 28.33       | 27.24 | 38.12       | 31.64 |
| 1200 | 25.78       | 21.51 | 28.28       | 27.37 | 38.72       | 32.02 |
| 1300 | 26.08       | 21.91 | 28.24       | 27.51 | 39.19       | 32.36 |
| 1400 | 26.45       | 22.31 | 27.56       | 27.62 | 39.32       | 32.66 |
| 1500 | 26.41       | 22.68 | 27.80       | 27.76 | 39.49       | 33.06 |
| 1600 | 26.42       | 23.08 | 27.96       | 27.85 | 39.36       | 33.34 |
| 1700 | 26.49       | 23.40 | 28.26       | 28.00 | 39.60       | 33.62 |
| 1800 | 26.44       | 23.79 | 28.54       | 28.06 | 39.73       | 34.18 |
| 1900 | 26.35       | 24.17 | 29.02       | 28.16 | *39.79      | 34.18 |
| 2000 | 26.28       | 24.41 | 29.50       | 28.20 | 39.80       | 34.20 |
| 2100 | 26.38       | 24.69 | 30.50       | 28.30 | 39.53       | 34.20 |
| 2200 | 26.66       | 24.94 | 31.60       | 28.40 | 39.60       | 34.20 |
| 2300 | 26.86       | 25.19 | 32.60       | 28.60 | 39.53       | 34.26 |
| 2400 | 27.06       | 25.35 | 33.40       | 28.70 | 39.33       | 34.28 |

\*The crest at the Concrete gage was later determined to be 39.89ft. at 1900 hours on 24 November.

24 November 1990

Temporary structure at Fir Island started to overtop at 1000 hours, and was completely cut through by 1100 hours.

Efforts were concentrated in problem areas that arose in previous flood event:

- In Sector E; County and dike personnel were again building a berm across SR20 at District Line Road.
- Dike District 1, a berm was constructed at entrance to West Mt. Vernon. The Fir Island side of levees along North Fork had severe erosion problems and were being monitored.
- Sandbagging and dumping operation was taking place along Skagit City Road. Water overtopping road near the South Fork bridge.
- Hill Ditch area; overtopping of levee and slope failure observed at Johnson Road. Sandbagging and dumping operation of approximately 200 ft. prevented further damage and overtopping.

25 November 1990

Although gage readings turned out to be higher during this second flood event, many sectors reported water levels up to two feet lower during peak. This was attributed in part to the levee break at Fir Island, and also to lower tides. Problems with both the Concrete gage and the Mt. Vernon gage prevented getting accurate readings.

- At 0400 hours Burlington was being evacuated due to overtopping of the structure along Lafayette and District Line Road at SR20.
- Emergency repair work at Johnson road was completed by 0500 hours.
- Operation along Skagit City Road was essentially completed by 0730.
- Areas in Dike District 17 (big bend) were being closely watched and seemed to be stabilized.

26 November 1990

Both gages were dropping rapidly, by 1200 hours visual readings were showed Concrete at 26.00 ft. and Mt. Vernon at 28.90 ft. Flood fight personnel spent the day surveying damaged areas.

# GAGE READINGS: CONCRETE AND MT. VERNON GAGES

| Time | 25 November |       | 26 November |       |
|------|-------------|-------|-------------|-------|
|      | Con / MtV   |       | Con / MtV   |       |
| 0100 | 38.96       | 34.30 | 27.91       | 33.60 |
| 0200 | 38.96       | 34.32 | 27.57       | 33.40 |
| 0300 | 38.29       | 34.32 | 27.28       | 33.00 |
| 0400 | 37.95       | 34.34 | 27.17       | 32.60 |
| 0500 | 37.58       | 34.34 | 26.97       | 32.30 |
| 0600 | 36.71       | 34.34 | 26.89       | 32.00 |
| 0700 | 36.13       | 34.34 | 26.63       | 31.60 |
| 0800 | 35.43       | 34.33 | 26.57       | 30.70 |
| 0900 | 34.74       | 34.34 | 26.41       | 30.60 |
| 1000 | 34.11       | 34.34 | 26.20       | 30.20 |
| 1100 | 33.25       | 34.34 | 26.11       | -     |
| 1200 | 32.73       | 35.20 | 26.00       | 29.60 |
| 1300 | -           | 35.25 | -           | -     |
| 1400 | 31.69       | 35.23 | 25.80       | 28.90 |
| 1500 | 31.33       | 38.05 | -           | -     |
| 1600 | 30.85       | -     | 25.70       | 28.20 |
| 1700 | 30.43       | -     |             |       |
| 1800 | 30.17       | 34.70 |             |       |
| 1900 | 29.53       | -     |             |       |
| 2000 | 29.40       | 34.20 |             |       |
| 2100 | 29.07       | -     |             |       |
| 2200 | 28.75       | 34.30 |             |       |
| 2300 | 28.47       | 34.10 |             |       |
| 2400 | 28.05       | 33.90 |             |       |

Problems with the Mt. Vernon gage prevented accurate readings throughout the flood event. The actual crest occurred at 1200 hours on 25 November, at a stage of 37.37.

4 December 1990

MEMORANDUM THRU Chief, Operations Division

FOR Chief, Emergency Management Branch

SUBJECT: Flood Fight, ~~24-26 November 1990~~, Snohomish River Basin, Washington

1. A weather system brought in warmer weather, wind and lots of rain to western Washington causing area rivers to flood. Snow that had accumulated in the mountains from the flood two weeks before melted creating additional flooding. At 0630 on 24 November 1990, the U.S. Weather Service predicted that the Snohomish River at Snohomish would crest at 33.0 feet, 6 feet above flood stage, by midnight 24 November 1990. With this information and the request of Snohomish County, personnel was dispatched to the Snohomish River at 0800 to begin flood fighting efforts. The following personnel reported to the Snohomish River base station:

|                   |                                 |
|-------------------|---------------------------------|
| Russ McCutchen    | Flood Engineer                  |
| Don Thompson      | Assistant Flood Engineer        |
| Olton Swanson     | Intelligence Officer            |
| William Hirano    | Assistant Intelligence Officer  |
| Janet Maxson      | Contracting Specialist          |
| Ginny Dierich     | Sector Engineer                 |
| Noel Gilbrough    | Sector Engineer                 |
| Jill Gough        | Sector Engineer                 |
| Norman Skjelbreia | Sector Engineer                 |
| Steve Erland      | Assistant Sector Engineer       |
| Henry Birchard    | Assistant Sector Engineer       |
| Hiroshi Eto       | Asst. Sector Engineer/Materials |
| Larry Ems         | Assistant Sector Engineer       |
| Peter Back        | Assistant Sector Engineer       |
| Grace Pitcher     | Administration                  |

Flood fighting efforts began at 1000.

2. The following activities were conducted on 24 November 1990:

a. The Skykomish River at Index was reported to have crested at approximately 0300 with a gauge reading of 4.5. By 1030, the river had dropped 2 feet from the crest. Five hundred sandbags were delivered to city hall.

b. Highway 2 at Sultan had 1 foot of water over the road. In town many roads had 2 plus feet of water over them. Businesses and homes sandbagged doors. One thousand sandbags were delivered to Sultan City Hall, temporary base of the local flood fighting effort. The Fire Station which is normally where flood fighting efforts are based was in accessible.

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SUBJECT: Flood Fight, 24-30 November 1990, Snohomish River Basin, Washington

c. The French Creek pump plant and drainage structure were observed at 1200. Pumps were off and the structures were in good condition. Temporary flood fighting efforts had been done between of the drainage structure and the Darlington's farm to prevent further erosion caused by the flood two weeks prior. Local farmers and residents continued through out the morning and early afternoon to evacuate livestock. Two farms chose not to evacuate livestock, but instead chose to place livestock on mounds on their property which are higher than the levee. Five hundred sandbags and one load of sand was delivered to French Creek.

d. At 0900 approximately 5000 sandbags were delivered to Stanwood. The Stanwood volunteer fire department had a flood fight well underway by this time. The two major areas of concern were under the Highway 532 bridge where they used approximately 200 cubic yards of pitrun and 2000 sandbags across the road and railroad tracks. The pitrun material worked better than the sand dikes they used during the flood two weeks prior. The only problem with the pitrun was trying to bond the material to existing high ground, but stripping the high ground of blackberry vines allowed for bonding of materials.

The other area that was flood fought was the low area of Highway 532, adjacent to the town. The dike that was placed two weeks ago during the flood was still there, so efforts concentrated on reinforcing the dike with pitrun and material that was excavated from the outside of the dike. The dike was also extended with sandbags.

The major advantage of this flood fight was that flood fighting efforts started about 4 hours earlier than the flood two weeks prior. The river crested about 1600 and stayed up most of the night. The flood fight was terminated about 1900, but fire fighters continued to patrol the levees throughout the night. A class on proper sandbagging technique would be of great benefit to the locals. Contact was made with Stanwood's mayor, Bob Larson about the possibility of a Section 205 Flood Control Study.

e. Corps personnel began directing sandbagging efforts on Ebey Island at 1300 with 10 people. At 1450, the county's amphibious tracked vehicle arrived at Ebey Island to assist in the flood fighting effort. An additional 40 people from Indian Ridge Correctional Facility arrived at 1600. An additional 30 sandbaggers were requested from and provided by Snohomish County Emergency Services. Additional volunteers showed up at the base station and were directed to Ebey Island. At 2000, the levees along Ebey Island were reported breached. The largest breach was located 10,000 feet downstream of Jackknife bridge and approximately 250 feet long. Two other breaches located 1,000

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SUBJECT: Flood Fight, 24-30 November 1990, Snohomish River Basin, Washington

feet and 600 feet downstream of Jackknife bridge were 80 feet long and 60 feet long, respectively. Sandbagging efforts continued at two locations, in the vicinity of the Highway 2 trestle on the Ebey Slough side of the island and near Bob Johnson's farm, until 2400 at one location. The second operation continued until approximately 0130 on 25 November. Personnel and equipment had to evacuate the island.

f. Hanson's dike in Monroe was reported breached at 1400. <sup>on 24 Nov 1990</sup> The breach is approximately 780 feet long.

3. The following activities occurred on the 25 November 1990:

a. A review of post flooding conditions along the Skykomish revealed that the water level in Sultan had dropped considerably from the previous day. No water was over Hwy 2 in Sultan and most streets in town were passible. At Index, the water was below flood stage. Some damage was observed just downstream of the railroad bridge along the riprap placed by the COE where it ties to the old riprap. An additional 5 foot area was also observed to have some minor damage.

b. A review of post flood conditions along the Stilliguamish River and contributing tributaries was conducted. At Stanwood, the water level had dropped 4 inches since the night before. Levees were inspected and contact made with Mayor Larson and the assistant fire chief. At Darrington contact was made with Fire Chief Jerry Booker and Snohomish County bridge engineer Dick Sass. Several levees and roads as well as two bridges were inspected along the north fork of the Stilliguamish and the Sauk River. Mr. Sass accompanied COE personnel as they continued to inspect levees and a washed out bridge downstream to Oso. Two bridges might qualify for a Section 14 are the bridge just out of Darrington and another just downstream of the confluence of the Sauk and Suiattle Rivers. In both cases the right bank just upstream of the bridges is eroding. Both bridges are in danger of failure during the next high water event. For location of the bridges contact Dick Sass, Bridge Maintenance Supervisor (388-3489), or Noel Gilbrough. One of the bridge is located in Snohomish County and the other is located in Skagit County.

c. Limited sandbagging at Bob Johnson's farm. Access only from top of levee near Homemaker Road. The a ship (SeaTac) and a house boat moored at District 13 broke loose. The SeaTac sunk next to a pier supporting the eastbound lanes of Hwy 2. The houseboat was traveled down Ebey Slough and was caught at Jackknife bridge. <sup>RPS</sup> ~~we~~ hired a tug boat (Cindy M) to move the houseboat because it was threatening damage to the bridge. No structural damage to the bridge occurred. The houseboat was relocated to a mooring in



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the Marshland District. At 1400, the water level in Ebey Island was 5 feet lower than the water level in the river. Severe overtopping has damaged the levee between the Hwy 2 trestle and Jackknife bridge along Ebey Slough and will require major reconstruction. A breach along Steamboat Slough in the vicinity of Monty Roads' property was reported, but the water level on Ebey Island prohibited COE investigation.

*COE*

d. The levy at Marshland was reported breached at approximately 1400. The Snohomish at Snohomish gage immediately reflected this break. The county evacuated approximately 30 people.

e. French creek opened the flood gates on the drainage structure for the first time. Ward Lawler, diking district commissioner, reported that the gates were working fine and the water elevation within the district was dropping.

f. Roads closed due to flooding included Hwy 2 across Ebey Island, Hwy 2 between Snohomish and Monroe, Hwy 9 south of Snohomish, and 88th Street into Snohomish.

g. Kelly Gustafson was dispatched to the Snohomish base station to assist in administration.

4. The following activities occurred on 26 November 1990:

*COE*

a. Coe personnel inspected local quarries for possible material sources. See attached summary of borrow sites.

b. French Creek diking district commissioners reported that the overflow levee is intact. A 20 foot breach along the Pilchuck River at the downstream end of the district was observed. The water elevation in the district had dropped such that the Darlington farm was able to start milking cows at 0500, 36 hours after the their milking parlor was flooded.

c. Limited sandbagging on Ebey Island between Homemaker Road and the pump house began at 1000. Effort focused on preventing erosion of the levee so that access out to the pump house would be maintained. Material for sandbagging was delivered to the site by the county. Approximately 10 sandbaggers were used and 100 sandbags were placed. Sandbags were being washed out of position, so the sandbagging effort was called off and work switched to three county trucks hauling pitrun material. The diking district provided a dozer. Trucks also hauled 4 to 8 inch spalls and 2 inch minus during the operation.

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SUBJECT: Flood Fight, 24-30 November 1990, Snohomish River Basin, Washington

d. A reported levee break at the confluence of the Sultan and Skykomish River was investigated. Property owners are the Stephens (793-2700).

e. Provided 1500 sandbags to the Lake Steven Sewer District located in District 2.

5. The following activities occurred between 27 and 30 November 1990:

a. Repair of break on Thomle Road one mile upstream of Stanwood began at 1600 on 27 November 1990. Equipment used in the repair work consisted of 10 dump trucks, a D-6 dozer and a vibratory compactor. The material used for closing the break was screenings from Pacific Quarry in Mount Vernon. The break was closed at 0300 on 28 November 1990 with approximately 1000 C.Y. of screening being used.

b. The repair of the Hanson dike in Monroe began at 1200 on 24 November 1990. Equipment used in the repair work consisted of 10 dump trucks, and a D-6 dozer. Material used for the repair was 30 inch minus material from Twin River Quarry. Work was called off at 2400 per direction from chief, Emergency Management.

c. The repair work for District 13 began 0900 on the 27 November 1990. Efforts focused on establishing access (one lane) into the district from Riverview Road. Riverview Road had approximately six breaches or holes eroded away by the flood. Equipment used in the repair consisted of 10 dump trucks (later increased to 13), and JD 450 dozer. A second JD 450 dozer was also hired during the project in order to work in two locations. The material used was 4 to 8 inch spalls and 2 inch minus from the Cadman Quarry in Monroe. The largest break in Riverview Road was where the mooring pier for the SeaTac used to be. This breach was approximately 200 feet long and over 20 feet deep in places. At the downstream end of District 13, the large break in the levee repaired two weeks prior breached again. This breach was approximately 250 feet. The other holes along Riverview road were approximately 30 feet long. Access into District 13 was completed at 1500 on 30 November 1990.

d. The Snohomish base station was closed at approximately 1530 on 30 November 1990.

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SUBJECT: Flood Fight, 24-30 November 1990, Snohomish River Basin,  
Washington

6. The following crests were observed:

| RIVER                   | ZERO DAMAGE | ACTUAL CREST              |
|-------------------------|-------------|---------------------------|
| Skykomish @ Goldbar     | 15.0        | 21.43 @ 1600, 24 Nov 1990 |
| Snoqualamie @ Carnation | 54.0        | 60.61 @ 2400, 24 Nov 1990 |
| Snohomish @ Snohomish   | 25.0        | 33.51 @ 1300, 25 Nov 1990 |

7. The estimated cost of the flood fight is \$ .  
Damages prevented is estimated at \$ .



Russell K. McCutchen  
Flood Engineer

## APPENDIX C

After Action Report, 9-20 November and 21 November-9 December Flood

16 January 1991

## AFTER-ACTION FLOOD REPORT

WASHINGTON, NORTHERN IDAHO, AND WESTERN MONTANA

9-20 NOVEMBER 1990  
21 NOVEMBER - 9 DECEMBER 1990

## 1. Event

a. Identification of Event

The first event was the result of extremely heavy rain falling over western Washington State for 40 hours from late 8 November 1990 through early 10 November 1990. Many rivers in western Washington exceeded flood stage, with the Nooksack river reaching its 25 year event and the Skagit river reaching its 20 year event.

The second event was again the result of extremely heavy rain falling over Washington State. Additionally, heavy rain fell over northern Idaho, and western Montana from 21-25 November 1990. Rivers throughout mid-western Washington flooded, with the Snohomish, Cedar, Skagit, and Wenatchee rivers reaching or exceeding their previous floods of record. Rivers in northern Idaho and western Montana also experienced flooding.

b. Contributing Factors

A series of tropical Pacific storms that moved through western Washington from 7-26 November 1990 brought the precipitation that caused the flooding. High temperatures melted the early season snow along the Cascades, adding to the flow in the rivers.

The storm of 21-25 November occurred before the precipitation from the previous storm had completely run off, resulting in much higher river flows than would be expected from the precipitation alone.

c. Storm Statistics

Cumulative precipitation measured by National Weather Service stations in the main watersheds in western Washington (from 1500 on 8 November to 1000 on 10 November):

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|              |      |
|--------------|------|
| Darrington:  | 5.8' |
| Marblemount: | 8.1' |
| Verlot:      | 6.1' |
| Skykomish:   | 9.0' |
| Snoqualmie:  | 9.2' |

Ross Dam reported a 24-hour rainfall amount of 9 inches, which is nearly a 100-year rainfall event.

The Nooksack River at Ferndale crested at 23.59 feet on 11 November. Maximum flow was 55,000 cfs that is equivalent to a 25-year event and is the new maximum of record.

The Sauk River at Sauk crested at 15.42 feet on 10 November. Maximum flow was 67,000 cfs which is equivalent to a 25-year event.

The Skagit River at Concrete crested at 40.20 feet on 10 November. Maximum flow was 148,800 cfs which is equivalent to a 20-year event.

Cumulative precipitation measured by the National Weather Service during the 21-26 November storm:

|              |       |
|--------------|-------|
| Glacier:     | 11.2' |
| Marblemount: | 6.7'+ |
| Darrington:  | 10.5' |
| Verlot:      | 9.6'  |
| Snoqualmie:  | 14.8' |
| Centralia:   | 6.1'  |

The weather stations at the Seattle-Tacoma airport and Olympia recorded new record rainfalls for 24-hour periods. The station at Sea-Tac recorded 3.56 inches ending at 1600 on the 24th, and Olympia recorded 5.90 inches ending at 1500 on the 24th.

The Skagit River at Mt. Vernon crested at 37.37 feet on 25 November. Maximum flow was 152,000 cfs, which is equivalent to a 25-year event, and is the new maximum of record.

The Stillaguamish River at Arlington crested at 20.00 feet on 24 November. Maximum flow was 64,700 cfs, which is equivalent to a 30-year event, and is the new maximum of record.

The Skykomish River at Gold Bar crested at 22.49 feet on 24 November. Maximum flow was 101,600 cfs, which is equivalent to a 50-year event, and is the new maximum of record.

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The Snoqualmie River at Carnation crested at 60.61 feet on 25 November. Maximum flow was 63,400 cfs, which is equivalent to a 25-year event, and is the new maximum of record.

The Snohomish River at Monroe crested at 25.42 feet on 25 November. Maximum flow was 186,000 cfs, which is equivalent to an 80-year event, and is the new maximum of record.

The Snohomish River at Snohomish crested at 33.33 feet on 25 November. Maximum flow was 165,000 cfs, which is equivalent to an 80-year event, and is the new maximum of record.

The Puyallup River at Puyallup crested at 26.99 feet on 24 November. Maximum flow was 41,200 cfs, and would have reached 61,000 cfs without the effect of Mud Mountain Dam. Maximum of record is 57,000 cfs, which occurred on 10 December 1933 (before Mud Mountain Dam).

The Cedar River at Landsburg crested at 10.28 feet on 24 November. Maximum flow was 10,600 cfs, which is equivalent to a 70-year event, and is the new maximum of record.

The Wenatchee River at Peshastin crested at 17.6 feet on 25 November. Maximum flow was 38,600 cfs, which is approximately equivalent to the 100-year event, and is the new maximum of record.

More detailed information on precipitation and river stages is included as Enclosures 2 and 3.

d. Areas Flooded

Nineteen counties in Washington State suffered flood damage in the two flood events. Based on the extensive flood damage, the President Bush signed a Presidential Disaster Declaration. The counties covered by the disaster declaration for both public and individual assistance, are Whatcom, Skagit, Snohomish, King, Mason, Grays Harbor, Wahkiakum, Lewis, Pacific, Thurston, Pierce, Jefferson, Clallam, Chelan, Island, San Juan, and Kittitas. Kitsap and Yakima counties were declared for individual assistance only.

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e. Damages

Two people in western Washington State lost their lives. Over 500 head of cattle were also killed by the flood waters. Approximately 3000 homes were damaged or destroyed, and over 1,072 National Flood Insurance claims were filed. FEMA's estimate of flood-caused damages is \$250,000,000.

On Fir Island, 8,000 acres of farm land and 167 homes were flooded as a result of a levee break. Repairs to the Fir Island levee system alone are estimated to cost approximately \$3,000,000. Total estimated levee damage throughout Washington is well over \$5,000,000. The old I-90 bridge crossing Lake Washington between Seattle and Bellevue collapsed during the flood period. Whether the collapse was flood-related is still being debated.

2. Missions

a. PL 84-99 Activities

Flood fight teams were activated for the Nooksack, Skagit, Snohomish, Chehalis, Yakima, and Cedar basins, as well as for the Olympic Peninsula in Washington State. The Coeur d'Alene basin in Idaho and the Kootenai basin in Montana were also patrolled by flood fighters. Flood activities for the first event began on 9 November and ended on the morning of 21 November. Flood activities for the second event began on the evening of 21 November and ended on 9 December. Total PL 84-99 Emergency Operations expenditures for the first flood were \$800,000, and for the second flood were \$1,600,000.

Flood fight activities included distribution of sandbags, technical assistance, and emergency construction by rental equipment.

Construction included a rock closure at the Fir Island levee break. This rock closure was overtopped during the second event and then rebuilt.

Work on the Snohomish River included temporary fix of the levee road in Diking District 13. This provided emergency access to a number of homes that were isolated by flood water.

Other work included emergency construction near the towns of Everson and Deming on the Nooksack River and two levees were reinforced on the Cedar River upstream from Renton, Washington.



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b. PL 93-288 Activities

On 17 November, FEMA requested Corps assistance to accomplish Preliminary Damage Assessments. Three Seattle District FEMA cadre members participated beginning 19 November. FEMA subsequently requested Corps assistance to prepare Damage Survey Reports (DSR's). Corps assistance began on 4 December with five FEMA cadre members, and grew to a total of 15 persons. Walla Walla District providing two, and Portland District provided three individuals.

3. Operations

a. Initial Response

The District Emergency Operations Center (EOC) was activated 9 November, and remained open throughout the two flood events. Flood fight and reconnaissance teams were dispatched to different basins as described above. These actions were the result of river stage predictions and requests for assistance from state and local authorities.

b. Coordination

Activities included working closely with county and city officials as well as State emergency response personnel. The District Engineer examined the affected areas by helicopter with Congressman Al Swift on 18 November and Congressman John Miller on 28 November.

At the time of the flood the Hiram M. Chittenden Locks had been closed and dewatered for repair and maintenance. When the old I-90 bridge collapsed, a large floating crane was needed at the site. At the request of the Washington State Department of Transportation the locks were reopened within eight hours. This involved moving all construction repair equipment from within the dewatered locks and then bringing up the water to a functional level.

The Skagit River Flood Engineer met with Marilyn Quayle and the National Director of FEMA at the Fir Island levee breach on 30 November.

c. Personnel Involved

Seattle District used approximately 60 field and 30 office personnel in flood-related activities. Portland District provided four flood engineers.

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d. Extent of Operations

Over 650,000 sandbags and 20 rolls of filter cloth were distributed in the two flood events. Total of contracts and procurement were approximately \$2,000,000. This included rental equipment, rock and other materials, and sandbags.

4. Commander's Assessment

a. Effectiveness of Activities

Local, state, and Congressional officials were very pleased with Corps efforts. Damaged levees on the Nooksack, Skagit, Skykomish, Cedar, Puyallup, Carbon, and Yakima rivers have been approved or are currently being considered for PL 84-99 post-flood rehabilitation. Permanent repairs should be complete by early spring.

b. Functioning of Projects

District regulation of flood control dams on various rivers is estimated to have saved over 360 million dollars in flood damages. This is especially significant in the Skagit valley, where the city of Mount Vernon would surely have been inundated if not for careful operation of the Ross and Baker dams which reduced the flood stage at Mount Vernon by at least three feet during each flood event.

A large degree of protection was provided by flood control operations of three other Western Washington dams operated by the Seattle District. The lower Puyallup River Valley industrial and residential area would have been inundated without the flood control operations of Mud Mountain Dam. The Howard A. Hanson Dam flood control operations reduced the peak stage on the Green River at Auburn by more than eight feet and prevented inundation of major residential and industrial areas from Auburn to Tukwila. The lower Wynoochee Valley also had a greatly reduced flood stage due to the flood control operations at Wynoochee Dam.

More detailed information on flood control operations is contained in the attached Memoranda for record: "After-Action Report - Flooding in Western Washington from 9-12 November 1990"; and "After-Action Report - Flooding in Western Washington from 21 to 26 November 1990."

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After-action Flood Report

c. Strengths/Weaknesses Observed

Strengths during the flood fight included the benefit of having well-trained flood fight personnel who had previously established coordination ties with local governments.

5. Lessons Learned

a. Flood Fight team training

The District has annual flood fight exercises in all basins. These exercises include having personnel familiarize themselves with local rivers, problem levees, etc. County and city officials are contacted and included in exercise activities. Also, during the year flood fight administrative personnel are trained at the District. North Pacific Division has biennial training in policy and procedures for PL 84-99. All this contributes to very efficient and effective flood teams at the Seattle District.

Recommendation:

Districts throughout the Corps could benefit by Seattle's example. Any District who feels they need help in this area may observe one of our flood exercises.

b. Cellular phone communications

Cellular phones are the newest aid to better communications during emergencies. The Seattle District Emergency Management Branch has ten phones that are used during a flood. They are an excellent supplement to radio as local officials may not operate on the same radio frequency as the Corps, but many have cellular phones.

Recommendation:

District should continue to keep cellular phones for emergency use.

APPENDIX D  
Newspaper Articles

Herald - 7-11-1990

# State rivers subside after

# hitting

# near-record levels

Associated Press

Heavy rains pushed rivers to near-record flood levels around Western Washington before subsiding Saturday, leaving weakened dikes and levees along four major northwest Washington rivers, officials said.

More than 500 people were evacuated, said Mark Stewart of the state Department of Community Development. Dozens more were unable to reach their homes or isolated by floodwaters in rural areas from the Snoqualmie Valley to southwestern British Columbia, more than 100 miles to the north.

Most concern focused on Whatcom County, just south of the Canadian border, where as much as 9 inches of rain was reported in 24 hours.

All but two or three major roads in the county were under water, and downtown Bellingham could face major flooding by today as Lake Whatcom rose to the level at which floodgates must be opened, said Dan Fitzgerald, deputy director of the Whatcom County Department of Emergency Services.

The number of people evacuated, stranded or unable to get home because of flooding was estimated at 300 to 500 in Whatcom County, 150 in Skagit County, at least 100 in Snohomish County and 10 in King County.

Hope Tuttle of the Red Cross in Seattle said about 550 people had been fed by the agency, including at least 60 who were staying in temporary shelters.

A shelter at Everson in Whatcom County was closed after being isolated by high water, and three Red Cross workers took shelter in a farmhouse after being stranded while trying to return home, Tuttle added.

Most of those displaced by flood waters stayed with friends and relatives, officials said.

The National Weather Service reported seven rivers cresting within a foot of record flood levels — the Cedar at Renton, the Skykomish at Gold Bar, the Snoqualmie at Carnation, the Snohomish at Snohomish, the Stillaguamish at Arlington, the Skagit at Concrete and the Nooksack at Deming.

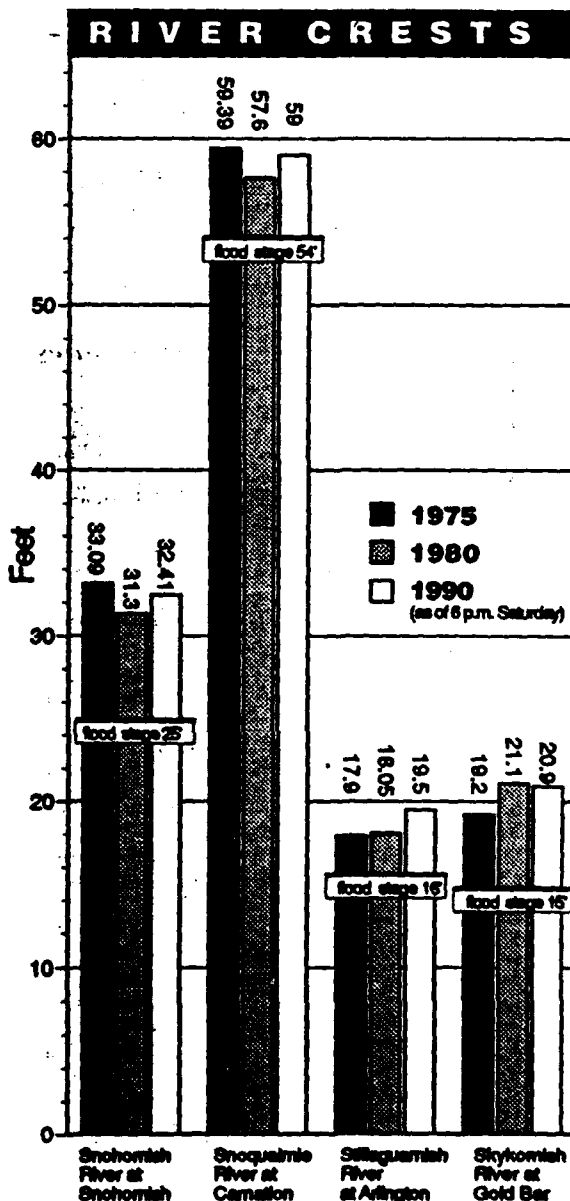
As the crests approached Puget Sound, authorities kept a close watch on protective embankments along the raging rivers.

About 32 people from the U.S. Army Corps of Engineers were assigned to sandbagging and other flood-control efforts, spokeswoman Patricia Cook said.

Along the Skagit, "It looks like we could get through with minimal damage, depending on the next weather system we get," said Dave Brookings, assistant flood control engineer in Skagit County.

If dikes along the river become soggy and unstable, "the whole lower basin is going to be vulnerable," Brookings said. "If we have a dike failure, that could be a disaster."

National Guard amphibious vehicles were used to get about 200 people out of Sumas on the Canadian border, Fitzgerald said.



# Dikes break on Fir and Ebey islands: 'Here we go again'

By Kathy George  
and Lisa Schnellinger  
P-I Reporters

FIR ISLAND, Skagit County — When the flood warning came at 5 a.m. yesterday, Eliseo and Cruz Viscalla didn't stop to save anything from their home of 37 years.

Fearing that the Skagit River might breach the storm-saturated dike any minute and flood their farm community south of Mount Vernon, they grabbed a blanket and got out.

But the dike didn't break until 1 p.m., and after that the floodwaters spread with agonizing slowness. Unable to return home, the Viscallas spent most of the day worrying about what might happen.

"We didn't know how much time we had," said Cruz Viscalla. "When something like this happens, your mind just goes blank."

The Viscallas weren't alone in their anxiety. About 200 others on Fir Island and about 100 residents of Ebey Island, a farming community east of Everett in Snohomish County, left their homes in fear of floods yesterday.

Snohomish County sheriff's deputies evacuated Ebey Island after a hole opened in the Snohomish River dike about 1 p.m. The break didn't turn out as bad as expected, and no damage was done, officials reported late last night.

Since Friday, rivers in Skagit, Snohomish, Whatcom, Grays Harbor and King counties have flooded after heavy rains from the "Pineapple Express" tropical storm system.

Weather forecasters said the rains will return to Western Washington by tonight. But they won't be as

heavy — "more like our usual" — and aren't likely to cause flooding, said Bill Palmer, forecaster for the National Weather Service in Seattle.

By early yesterday evening, the most swollen rivers in King and Snohomish counties had fallen to just above or below flood level. Most floodwaters receded steadily in yesterday's sunshine.

But several dozen roads, including some highways, remained closed.

On Saturday, flooding forced more than 500 people from their homes and washed out roads throughout Western Washington.

After a helicopter tour yesterday, Gov. Booth

Gardner declared an emergency in the five flood-ravaged counties, making them eligible for general state aid and for federal highway repair money.

After flood losses are assessed, he'll decide whether to ask President Bush to declare a federal disaster area. That would provide more wide-ranging federal aid.

On Ebey Island, flooding is a fact of life, and residents seemed resigned to it yesterday as they packed up belongings and fled. Several recalled

See FLOODING, Page A4

Booth & S

Nov 12, 1990

## Flooding: Volunteer sandbag brigade saves Mount Vernon's business area

From Page 1

being evacuated in 1986 and 1975. "Here we go again," said Fran Conner, who has lived in the community 16 years. "Living down here, you know this is going to happen."

At the Red Cross office in Everett, Linda Brooks and her staff made sandwiches for crews trying to shore up the river dikes and prepared to help displaced families.

"Welcome to insanity," she joked.

The Red Cross set up three shelters in Skagit County and one in Whatcom County to house about 100 people chased out by floodwaters. The agency provided more than 2,000 meals over the weekend to stranded residents and travelers.

Officials are concerned about the extent of road damage, said Meredith Mamanakis at the King County Flood Warning Center.

"This is one of the bigger floods, and almost as big as the one in 1986," Mamanakis said. It could take most of today to clear away debris and assess damage from the flooding Cedar and Snoqualmie rivers, she said.

The potential for more dike damage along the Snohomish had diminished last night, a spokesman reported.

About 40 volunteers had worked to repair the dike in the afternoon, and officials expected to finish the job before high tide at 1 a.m. today.

Some dikes around Ebey Island could use reinforcement,

### Road closures

These highways were closed last night by floodwaters or mud and rock slides. They may reopen today.

Many local roads in King County's Snoqualmie River Valley also were closed.

#### Snohomish County

State Route 530 at several points.

#### Skagit County

Highway 20 at Marblemount. At Lyman, the water was 12 to 18 inches deep but the highway remained open.

Highway 11 (Chuckanut Drive) at Cook Road for one mile.

Highway 9 at several points.

Interstate 5 at the Alger exit, though traffic was being routed around it.

#### Whatcom County

Highway 542 at Maple Falls and at Boulder Creek.

Highway 539 at the Nooksack River bridge.

Highway 20 about 1½ miles east of Anacortes.

Interstate 5's Axon exit, northbound.

said. The county's public works department is attempting to bring the districts together to coordinate future work, he said.

Throughout the region, volunteers poured out to help sandbag river dikes and to help landowners protect their property.

In Mount Vernon, hundreds of people piled sandbags on the main riverfront road late Saturday and early yesterday. The sandbags prevented flooding of the downtown business area.

"Without them, this would have been a disaster," said Dave Brookings, assistant flood control engineer for Skagit County.

For Norm Perreault, owner of the Glacier Creek Motel in Whatcom County, the help he got from neighbors and strangers alike almost made the flood horrors worthwhile.

When water from Gallup Creek threatened the cabins of his motel on Highway 542 near Mount Baker, scores of volunteers showed up to help shovel sand into bags and stack them around his property.

"People would just be driving by and see us sandbagging, and they'd stop and help for two or three hours. And then more people would show up," he said.

Perreault and his wife left jobs in Seattle seven years ago because they'd had enough of city life. The flood experience just reaffirmed that they'd made the right decision, Perreault said.

"The people are just great," said Perreault, assistant fire chief for the town. "We all rally together, whenever anyone needs it."

said Michael Razey, interim director of emergency management for Snohomish County.

"Each diking district does it (reinforcing) when they can afford it, . . . but they're each small," he

Nov. 13  
Seattle  
Times

## Fir Island in danger of becoming part of bay

Flood water coming in  
faster than it's receding

by Rick Lund  
Times staff reporter

CONWAY, Skagit County — Workers have punched a hole in a dike to drain flooded Fir Island, but water from the raging North Fork of the Skagit River is filling the island faster than the water can leave.

As some of the last of the 450 residents of the island were evacuated last night, the water level continued to rise to meet the gradually receding waters of the Skagit River. Water is reportedly as deep as 10 feet.

"I've got 7 feet of water at my house," said Ruth Wylie, Skagit County commissioner and long-time resident of Fir Island. "It's raining, and there's more rain in the forecast. It looks pretty glum right now."

Officials had hoped the 150-

I've got 7 feet of water  
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Ruth Wylie

Fir Island resident

foot-wide hole on the saltwater dike at the mouth of Dry Slough would lower the water levels on Fir Island. Water is emptying into Skagit Bay, and Wylie said last night that the swath in the dike will be widened to 250 feet. But water continues to pour at a faster rate through the 200-foot hole on the river dike that burst open Sunday on the island's north end.

Crews today were to begin building a road to reach the place where the river dike broke. That break sent a wall of water 10 feet high over fertile farm land, forcing the evacuation of island residents and several thousand head of cattle.

But it might be several days before the dike can be repaired.

"The difference between the water moving off Fir Island and the water moving onto the island is there's the force of the river behind one," said Don Nelson, county flood-control engineer. "We need to repair that river dike as soon as possible."

"We're draining the water on one place on the island," Nelson said. "But if the water gets too deep and the saltwater dike gets too soft, it could break in 25 or 30 places. And then you've got a real problem."

"If the entire dike breaks, then Fir Island becomes a part of Skagit Bay," Nelson said.

The river dike that broke Sunday afternoon started as a 50-foot gap and doubled in size "within 20 minutes," according to area resident Pat Dozier, who was among

Please see ISLAND on B 2



# Water coming in faster than it's receding

## ISLAND

continued from B 1

dozen workers frantically trying to patch the dike.

"The dike felt like jelly," Dozier said. "It felt like an earthquake under your feet. We all got out of there fast just before it blew. If we would have got caught in the path of that water, we would have been history. Waves were 8 to 10 feet high. I saw it wipe out a fence row." Built after the county's last great flood in 1951, the dike, according to island residents, wasn't strong enough to with-

stand flood waters. Unlike the dike on the east bank of the south fork of the Skagit River, which has undergone considerable improvements in recent years, the Fir Island dike has not been properly maintained, residents say.

"If that dike was maintained like the District 3 dike (on the other side of the river), this probably wouldn't have happened," one farmer said.

As if the threat of more flooding weren't enough, there's also the threat of high tides backing onto the island. Nelson said river water will dilute the saltwater, but the presence of saltwater on prime farmland doesn't bode well for crops.

"I've seen what saltwater has done to peas," he said. "They grow 2 inches and wilt. There's a lot of pea farmers on Fir Island."

And a lot of farmers are in a world of hurt. Many don't have flood insurance, including longtime Fir Island farmer Dal Wylie. He estimates he has 9 to 10 feet of water at his house.

"I lost everything," Wylie said. "All the farm machinery, pumps, lawn mowers, motorcycles are under water. We moved some equipment to higher ground, but we never thought the water would get this high. We've had floods, but old-timers say this is the worst - ever.

"We've never had water this high on Fir Island," he said.

Nov. 13  
Seattle PI

# Bitter Snohomish River neighbors say dike added to their problems

By Scott Miller  
and Lynn Steinberg  
PJ Reporters

**SNOHOMISH** — Born on the Snohomish River 83 years ago, Fennis Roetisoender has seen a lot of floods invade his riverside pasture.

There was the big flood of 1921. Another in 1975. And again in 1986.

But few wreaked such havoc as this past weekend's torrent, he said. Like many of his neighbors, Roetisoender blamed the towering dike built across the river for channeling the flood's fury in his direction.

"They spent millions over here. They never spent nothing here," the retired farmer said.

Flood victims yesterday surveyed the damage and vented their frustrations as rivers slowly

receded to expose the mud and debris left in their soggy cars, yards and homes.

Some areas of Western Washington remained under water and could stay that way for up to two weeks. Closed roads prevented hundreds of people from returning to their homes.

"Not since '51 have we had a flood of this magnitude," said Larry Libby, a spokesman for the Skagit County Department of Public Works.

Another storm is expected to dump an inch or two of rain in the North Cascades by this afternoon, minuscule compared to the tropical-fed storm that brought more than a foot of rain in four days to parts of Western Washington.

Bruce Renneke, lead forecaster for the National Weather Service in Seattle, said last night that the Skagit River at Concrete,

Wash., has a normal flood level of 28 feet. He said that at 7 p.m. yesterday, the river was at 28.8 feet and was expected to reach about 33 feet by 10 p.m. today.

Though the water had begun to recede, frustration and anger remained high along the north bank of the Snohomish River.

Residents say high dikes on the other side of the river left the raging waters with nowhere to go except into their fields and homes. The northsiders say their homes are unprotected because they have less land and money than their counterparts across the river.

"They got the bucks — they got the big landowners over there," said Robbin Freeman, whose home was surrounded by water over the weekend.

Looking over the gray flood plain that covered his 83-acre farm, Roetisoender agreed.

"We're nothing. They're big shots over there," he said.

But southsiders say you get what you pay for.

"They always say that," re-

sponded Jim Misich, who owns four farms in the Marshland district. "It's like saying, 'I got rained on harder because they have a roof.'"

There are more than a dozen flood-control districts in Snohomish County, each with its own elected representatives and its own agenda. The county has tried, unsuccessfully, to coordinate these agencies.

"They've talked," said county engineer Gerald Weed, "but the action is not there to sustain the talk."

The Marshland Flood Control District, on the south side of the Snohomish River, has been particularly resistant to change. The district was established about 40 years ago and takes in many of the area's largest farms.

It taxes property owners \$30 an acre, which allows the district to maintain a \$120,000 annual budget — which easily covered the \$20,000 it spent Saturday for crews to shore up the dike on the left bank of the river.

Although some of the area was

flooded, it didn't sustain near the damage that was done on the north side of the river. And that fueled a long-standing debate about the Marshland district contributing to problems across the river where protection again: the rising waters isn't nearly as good.

But others say the flooding will persist until the flood-control districts unify.

Damage from the weekend storm was widespread.

The Nooksack River in Whatcom County forced 500 people from their homes. Among the areas hardest hit by floodwater were Ferndale, Sumas and Everett. But there were more. "Take a map of the Nooksack and pick your city," said operations chief John Gargett when asked to highlight the damage in Whatcom County.

The road to the dock for the Lummi Island ferry was cut off. An alternate route was set up at the Alaska ferry terminal in Bel-

See FLOOD, Page B2

## Flood: Debris heavily damages 4-mile section of Chuckanut Drive

From Page B1

lingham.

Debris damaged State Highway 11, the Chuckanut Drive, and a four-mile stretch may be closed up to 30 days. Road closures have severely limited east-west travel.

Residents near Highway 11 just north of Larrabee State Park were not permitted to return home yesterday, and Gargett estimated it would be at least another day before the area is determined to be safe.

State emergency workers said 16 bridges in the county required inspection. Hargett said many homes still are inundated with water. Three in Glacier Springs are beyond repair.

The Skagit River receded yesterday, but not as fast as it rose the day before. "It took five hours and 15 minutes to drop 1 inch," said Libby, the public works spokesman. The river crested at 35 feet, 7 feet above flood stage.

Damage was most severe on Fir Island, where a 50-foot break in a dike Sunday widened to 250 feet yesterday. Repairs will begin today and could take one week.

"Three-fourths of the island is under water," said Mark Stewart, spokesman for the state Department of Community Development, which oversees the emergency management division.

About 350 of the island's 450 residents heeded advice to evacuate, and 600 dairy cows were moved to other farms. Some homes were still submerged in 8 feet of water yesterday, said Tom Sheahan, director of the county's Department of Emergency Management.

Emergency workers dug out the lower portion of the dike to release some of the water and relieve mounting pressure. They hope that will save the dike.

Snohomish County officials were fielding call after call from people trying to get home and get settled, said Jerry Aaron, coordinator for the county's Department of Emergency Services. About 300 people had to be evacuated from areas around Sultan, Gold Bar and Stanwood.

Ebey Island, which was threatened Sunday, was able to hold back the floodwaters. Residents and emergency workers were shoring up dikes yesterday in anticipation of the high tide and the approaching storm.

County, state and federal emergency workers were starting to assess the damage yesterday, but no specific dollar amounts were available.

The final tally will determine whether Gov. Booth Gardner will seek federal disaster relief that could enable individual property owners to get financial assistance for repairs.

Seattle Times Nov 14, 1990

# Crews continue efforts to release flood waters on soggy Fir Island

by Chuck Taylor and Dee Norton  
Times staff reporters

CONWAY, Skagit County — The swollen Skagit River, which has flooded nearby Fir Island with several feet of water since rains began late last week, created at Mount Vernon early today and began receding.

The river dropped a foot to a foot and half overnight, receding to 2 feet above flood level, Rick Boge with the Skagit County Public Works Department said today.

It's been dropping about an inch an hour since 3 a.m., but Boge said it will be at least 24 hours before county crews and volunteers can get a reading on what to do next.

Water depth on the island is now between 4 and 6 feet. The water isn't expected to drain away until the river drops to 28 feet, which is flood level, Boge said.

Water wasn't dropping as fast as officials had hoped, despite three deliberate breaks made in the dike.

Throughout the night, flood-relief workers, volunteers and some 1,185 affected residents anxiously tended walls of sandbags piled high to shore up dikes, protect homes and block storefront entrances.

Mount Vernon is a city already so saturated that



The flooding North Fork of the Skykomish River buckled a section of the Index-Galena Road about eight miles northeast of Index.

Mike Vorhe

Please see **FLOOD** on A 8

# Skagit falls; rains abate

## FLOOD

continued from Page 1

storm drains last night were bubbling water up through foot-deep street puddles during a thunderstorm.

Sandbags along the downtown district have barely held the Skagit in check.

The forecast, at least, is somewhat encouraging. Dana Felton of the National Weather Service in Seattle predicted rain decreasing to periods of showers by tonight.

"The main system that gave us the steady stuff is east of the Cascades now," Felton said. "But then it looks like we have another system coming in Thursday afternoon." A freezing level as low as 3,000 feet, however, means moisture in the mountains upstream will be snow, not rain.

But the last few days of off-and-on rain have swelled Western Washington rivers again.

In anticipation of the latest flood water, Skagit County Commissioner Bill Vaux threw the switch on 300 pounds of dynamite last night, blasting about another 50 yards of earthen dike on the Skagit Bay side of Fir Island.

"It's a gusher," he said. "It's just shooting through." It became the third man-made break in a dike that was designed

## Developments in the flood

■ Flood warnings still in effect for the Skagit River in Skagit County and the White River in Pierce County.

■ Closed highways Highway 9 at the Whatcom-Skagit county line; Highway 11 (Chuckanut Drive) south of Bellingham; Highway 20 (North Cascades Highway) at Newhalem; Highway 237 at the Samish River in Skagit County; Highway 542 in Whatcom County at Boulder Creek.

■ Damages Very roughly estimated at \$20 million in Whatcom and Skagit counties. The state has asked the Federal Emergency Management Agency to help determine if Gov. Booth Gardner should request federal disaster assistance. FEMA representatives will join state and local officials Friday to assess damage to homes in hard-hit Skagit and Whatcom counties. Other counties have not made damage estimates.

■ Whatcom County Flood waters from the Nooksack River damaged a number of towns, including Ferndale, Sumas and Everson. About 1,000 residents have been displaced. The Nook-

sack crested yesterday and is falling.

■ Skagit County 1,185 residents were affected by flooding, some of whom have returned to their homes. Fir Island at the mouth of the Skagit River is mostly under water. Other riverside areas where flooding has displaced residents: Cape Horn, Thunderbird Lane, Allen and Hamilton.

Mount Vernon's waterfront is sandbagged and some streets are flooded by storm-drain backup.

■ Snohomish County The Snohomish, Skykomish and Stillaguamish rivers were all below flood level yesterday. But most residents living in about 25 homes just southwest of Stanwood, forced to evacuate over the weekend, were unable to return yesterday, as were occupants of another dozen houses in the Sultan-Index area.

As of last night, 17 roads remained closed in the county, including Marine Drive just south of Stanwood, Riverview Road and the Lowell-Snohomish Road.

Times staff and Associated Press

to keep saltwater out - but has been holding fresh water in.

Fir Island is a low-lying triangle of farm land roughly 4 miles by 4 miles by 6 miles in size, defined by the north and south forks of the Skagit and surrounded by dikes. The dikes are supposed to keep it dry, but lately it's been a giant bathtub.

Two other breaks in the saltwater dike were cut Monday, one with dynamite and the other with cranes.

But flood water was pouring in through a break of nature's making, near the upstream corner of the island, faster than the relief

valves to Puget Sound were able to drain it: So the third break was made last night.

Some 500 rural residents of Fir Island are staying with friends, relatives and innkeepers. Another 100 have declined to leave - most of them on the relatively unaffected east side of the island, said Donald McKeen, spokesman for the Skagit Department of Emergency Management.

Displaced residents also were being assisted by the American Red Cross, which had served 5,900 meals from three shelters in Skagit

County. The Red Cross - which yesterday closed 10 shelters in Whatcom, Snohomish and Skagit counties as flooding subsided - still is feeding 100 National Guard workers in Conway.

Rivers in Whatcom and Snohomish counties, which also reached flood stage, have since receded.

Residents, unaccustomed to flooding this severe, are being ferried by volunteers in small motorboats to check on their houses.

■ Times staff reporter Tomas Guillen contributed to this report.

# Water contamination feared in flood

11-17-90

by Richard Seven  
Times staff reporter

As the water level on Fir Island continued to drop about an inch per hour, Skagit County emergency officials yesterday turned their attention to potentially severe water-contamination problems.

"Because this is a farming community we have to worry about contamination from the sewer tanks, animal waste, fuel tanks, pesticides, all that," said Donald McKeen, Skagit County Emergency Services spokesman. "We're urging people considering going back to their homes to talk to us first."

A thick oily sheen floats on the surface of the water, which was as deep as 8 feet a few days ago but closer to 4 feet yesterday. State Department of Wildlife agents are concerned about habitat damage to a game reserve on the island.

Floodwater will continue to plague the sunken farmland community until the Army Corps of Engineers can close a massive breach in a levee that gave way Sunday. Because the island is surrounded by dikes and levees, water from the Skagit River became trapped.

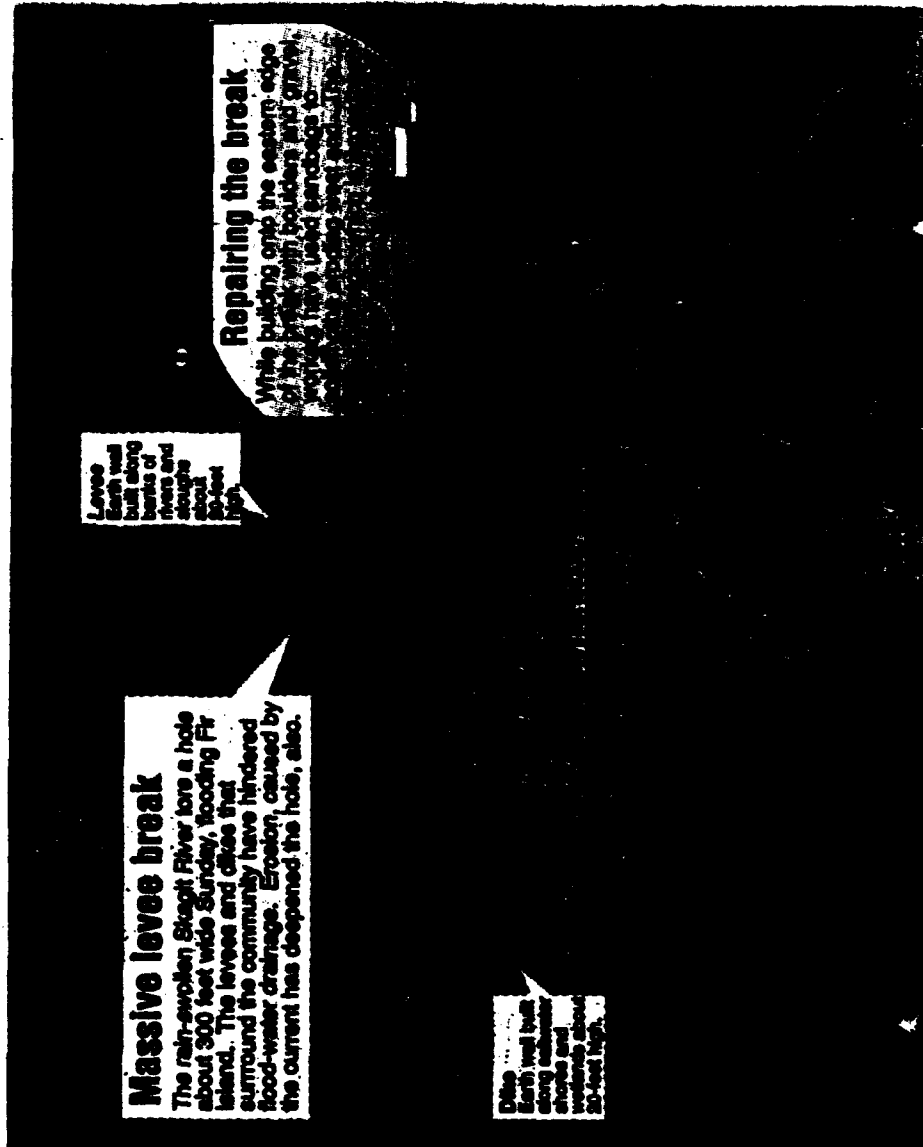
Workers were to place about 5,000 sandbags on the downstream side of the earthen levee's break to stem its erosion.

While building a boulder-and-gravel plug from the upstream end of the break, workers fear they may have aggravated erosion on the downstream end of the break by channeling more of the current toward it.

The corps is estimating the break won't be sealed until Tuesday or Wednesday.

The makeshift patch will be 350-foot long because it is being built across the water in a banana-shape to avoid bottom holes as much as 40-feet deep.

Strong currents have "scoured" the river bottom,



## Massive levee break

The rain-swollen Skagit River tore a hole about 300 feet wide Sunday, flooding Fir Island. The levees and dikes that surround the community have hindered flood-water drainage. Erosion, caused by the current has deepened the hole, also.

Levee Earth wall built along banks of river and dikes about 20-feet high.

## Repairing the break

While building onto the eastern edge of the break with boulders and gravel, workers have used sandbags to seal the eroding area.

Dike Earth wall built along outside of river and dikes about 20-feet high.

Please see **WATER** on A 8

Randee S. Fox, Rob Kemp, Janua McFarlane / Seattle Times

## Water may be unsafe

### WATER

continued from Page 1

erupting the deep pockets, said corps spokesman Dave Harris.

Despite working around the clock since Wednesday afternoon the Corps of Engineers had closed only about 85 to 90 feet of the break by early last night.

Twenty-five trucks have each been shuttling in 5 to 6 cubic yards of rock per hour for two days, said Nick Mickels, of the Department of Natural Resources.

About 29,000 cubic yards could be needed to close the hole, said Mickels.

The island, a sunken triangle of farmland, has been under water since the flooded north fork of the river burst the earthen levees Sunday.

Holes punched in the dike that holds back Skagit Bay have helped drain the water and relieve pressure on the dike, which is designed to absorb outer, not inner force.

The trucks have been carrying large boulders and gravel from nearby quarries to the break. After boulders are dumped into the river, gravel and dirt are pushed in on the current side to solidify the blockage.



Tom Hulbert removes debris from his uncle's yard on Dry Slough Road near Fir Island. Pedro Perez / Seattle Times

About 500 people and 2,000 head of livestock have been evacuated from the island.

In addition to state and federal workers and national guardsmen, volunteers and inmates of the Indian Ridge Correctional Center have aided the salvage effort.

Representatives from the state Department of Community Development and the Federal Emergency Management Agency began making damage assessments of private property in Skagit and Whatcom counties.

Evaluation of damaged public facilities, such as roads and bridges, begins Monday.

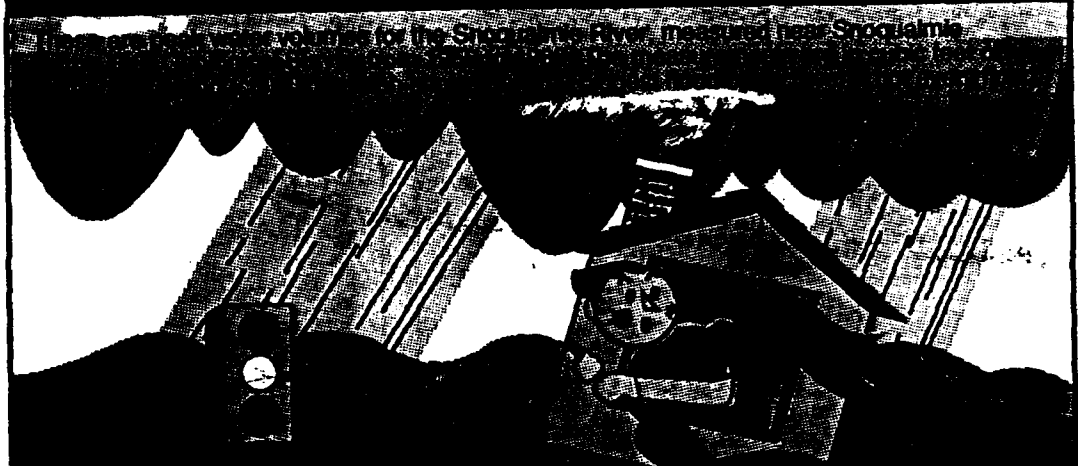
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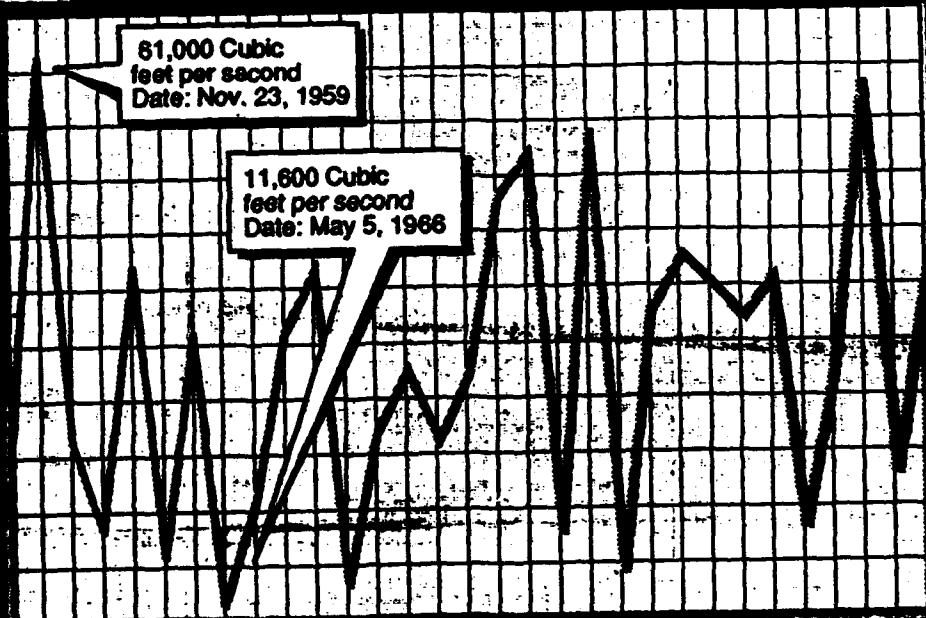
Allen's P. C. B Est. 1888

## Snoqualmie River floods

The graph below shows the volume of the Snoqualmie River, measured near Snoqualmie



In Thousands



Years



# Area braces for Flood II as rivers rise

## Rain, wind batter county; thousands lose electricity

By **JIM HALEY**  
Herald Writer

Fast-rising rivers in eastern Snohomish County sent some residents fleeing Friday night as the area braced for its second flood in two weeks.

Flood warnings were in effect for the Skykomish, Snohomish, Stillaguamish and Snoqualmie rivers, although no major flooding was reported. Warnings also were issued for four other Western Washington rivers — the Elwha, Skagit, Nooksack and White.

The high water was added to gale-force winds that knocked out power, buffeted bridges and snarled traffic Friday afternoon in Western Washington.

The National Weather Service said

the flooding shouldn't reach proportions of the Western Washington flood two weeks ago. But some rivers rose several feet in a few hours.

Four people at the Thunderbird Resort off the Ben Howard Road between Monroe and Sultan asked for help getting out around 11 p.m., said Mike Razez of the Snohomish County Department of Emergency Management.

The Stillaguamish River flooded a neighborhood seven miles west of the town, forcing the evacuation of two or three households, said Darrington Fire Department spokesman Dale Hamlin. Another family was evacuated from the Stillaguamish Country Club area, he said.

A few residents near the Sauk

**See STORM,**  
back page, this section

River's Clear Creek tributary also left their homes on the advice of firefighters, Hamlin said.

Snohomish County sheriff's deputies were responding about midnight to a report that a family became stranded after a mudslide cut off their car on a mountain road near Green Mountain. A woman hiked 16 miles to the Mountain Look Highway east of Granite Falls to summon aid for three people she left behind, officials said.

"We're very concerned about the rapidly rising rivers in the eastern part of the county," Razez said. "We'll be keeping a close watch on those the rest of the night."

Emergency officials were looking especially hard at the Stanwood and the Silvana area, where many homes were flooded two weeks ago. A high tide was expected to back up the Stillaguamish this morning.

The National Weather Service predicted the Snohomish River would rise to five feet above flood stage by midday today and might climb another foot or two before cresting.

Both the Skykomish and Stillaguamish rivers also were expected to rise a foot or more above flood stage by morning or afternoon, meteorologist Bruce Renneke said Friday night.

"It's not quite as bad as the last one," Renneke said. "But it will test the dikes and levees."

By 9 p.m. Friday, emergency management reported water over Swede Haven Road, north of the Stillaguamish River's north fork and west of Darrington, and over roads in the Sultan area.

An evacuation center was opened by the American Red Cross at Sultan Community United Methodist Church

# STORM

from Page 1



Three men watch the rain-swelled power of Granite Falls on the south fork of the Stillaguamish River.

The Herald/FRANK VARGA

at 212 Birch Ave. Winds gusting to 72 miles per hour Friday forced a temporary closure of the Hood Canal Floating Bridge on the Olympic Peninsula. Wind-blown waves washed over the Evergreen Point Floating Bridge on Lake Washington, temporarily disrupting traffic.

In Eastern Washington, southerly winds gusting to 50 mph stirred up dust clouds, reducing visibility in the Spokane and Pasco areas. No major damage occurred, said Jim Mitchell of the National Weather Service in Spokane.

Locally, the Snohomish County PUD clocked wind gusts of 55 mph just after 2 p.m. and 49 mph a short while later, utility spokesman Dean Harris said.

A tree blown down near the Park Ridge substation northeast of Canyon Park took out a power transmission line. More than 18,000 customers from there to Edmonds and Lynnwood were without electricity for a while, Harris said.

Besides south Snohomish County, PUD crews responded to scattered outages and more severe incidents on Camano Island and areas near Arlington.

Friday's post-Thanksgiving gale also darkened the area's largest shopping mall for more than an hour on one of the busiest holiday sale days of the year, catching throngs of shoppers by surprise.

Emergency lighting came on in some areas and some store managers had flashlights, but most stores closed because they couldn't record sales without their electrically-powered computer cash registers.

"There were thousands and thousands of people," said Andrea Christenson, acting mall manager. "A lot of people stayed rather than go out into the traffic because all the traffic lights were out. There wasn't anything else for them to do, so they

just took a seat and waited." In British Columbia, flooding forced at least 40 people from their homes in the Vancouver Island community of Sayward. A flooding Gold River, about 150 miles northwest of Victoria, kept 50 members of the Mowhachat Indian band from returning to their reservation, police said.

No injuries were reported. A "quick and heavy surge" of rain Friday evening in eastern Snohomish County led to the new river predictions. More than an inch of rain fell in a three-hour period in Darrington, Index and Verlot, said Renneke of the Weather Service.

The rain pushed the Skykomish River at Gold Bar from far below flood stage to nearly four feet above in just a few hours, Razey of emergency services said. Falling weekend temperatures should turn the rain to snow in the Cascade Mountains and prevent serious flooding, Renneke said.

"Rivers will go up a little bit until the cold front hits," Renneke said. "Rivers and temperatures will fall on Sunday for sure."

The Weather Service predicted mixed snow and rain at Snoqualmie pass this morning and snow was expected at higher Stevens Pass. Snow could be heavy at times at Stevens by tonight or Sunday, forecasters said.

Although the lower freezing level should ease the flood threat, it's not good news for travelers at the end of the Thanksgiving holiday.

State emergency officials predicted waters will not rise as high as they did on Veterans Day weekend when hundreds were forced from their homes by floods. Two weeks ago, flood waters

In Skagit County Friday, emergency officials and U.S. Army Corps of Engineers piled up sandbags and checked soggy dikes on Fir Island and Cockerham Island. The Corps of Engineers has sent 50,000 sandbags to the Skagit River Basin to protect from further flooding.

Recent flooding submerged 8,000 acres of Fir Island and forced nearly 500 people to evacuate their homes, many of which are still uninhabitable.

Damage from the flooding earlier this month in Snohomish, Skagit and Whatcom counties was tallied at more than \$40 million.

The Associated Press contributed to this report

# An anxious night for flood victims at mouth of Skagit

by Kate Shatzkin  
Times staff reporter

Seattle Times

Nov 24

FIR ISLAND, Skagit County — For Fir Island residents, last night was a cruel waiting game.

The swollen North Fork of the Skagit River has flowed through a broken levee to keep this river-delta farming community under water the past two weeks. The rising river yesterday kept workers busy as they tried to close the gap and shore up saltwater dikes.

The river was at flood stage — 28 feet — and rising last night. The National Weather Service predicted it would crest at 30 to 32 feet sometime today.

Just how high that crest will be was uncertain last night.

Water levels upstream at the town of Concrete were to be watched overnight to determine whether sandbagging would resume today here at the mouth of the Skagit, said David Brookings, assistant flood control engineer for the Skagit County Public Works Department.

At first, officials expected the river to crest at 29 feet — a point at which they would be able to head off a repeat of the first flood, which left parts of Fir Island under 8 feet of water.

"That amount of water normally causes us zero

## RIVER

continued from Page 1

problems," said Brookings.

But with more rain in the region bringing more water downstream, the situation yesterday was anything but normal:

■ Saltwater dikes on the Puget Sound side of the island were unstable, eroded by high winds and fresh water pressing against their inner lining. Brookings said at least four breaks occurred on

the saltwater side of the island yesterday.

Volunteers and the Corps of Engineers packed the dikes with sandbags and rock fill but shied away from a more permanent solution, so the water can be drained once the flood danger passes.

■ The corps piled 4 feet of fill to patch the 300-foot hole ahead of the river. But the closure could only be built 31 feet high because it became too narrow for trucks to travel on it to drop fill. Above that level, residents will have to use sandbags.

Corps civil engineer Joe Vasey looked grim as he directed trucks across the break. He said fierce winds kept the Skagit Bay area at high tide all day.

"Nobody really knows what will happen," he said. "This is the only thing to do."

■ Skagit County officials also feared flooding at Cockerham Island outside the town of Hamilton, upstream from here, where levees were weakened from heavy rains.

Volunteers ate Thanksgiving leftovers at the Conway Volunteer Fire Department last night and

waited to be called out. About 3,000 sandbags were stockpiled nearby.

Many residents still have not moved back into their homes and have only returned to clean up. They were hoping not to have to do it again.

With many of his 210 acres of land underwater, farmer Joe Tellesbo watched the water level anxiously from his home on Dry Slough Road. He was determined to stay put.

"I stayed here through the last flood all alone," he said. "And I hope to stay here this time."

**SUNDAY**  
November 25, 1990

**The Herald**

For LYNNWOOD, EDMONDS,  
MOUNTLAKE TERRACE, BRIER,  
and MILL CREEK AREAS

98th Year No. 341 1990 The Daily Herald Co.

# Rivers flow with disaster

**Snohomish  
heads for  
record level**

By SHARON J. SALYER  
and ERIC ZOSCHKE

Herald Writers

Caught in a new surge of rain in Western Washington, the Snohomish and Stillaguamish rivers climbed to record-breaking levels Saturday.

In addition, the still-rising Snohomish River was expected to break water volume records overnight. County Executive Willis Tucker issued a formal declaration of emergency Saturday night.

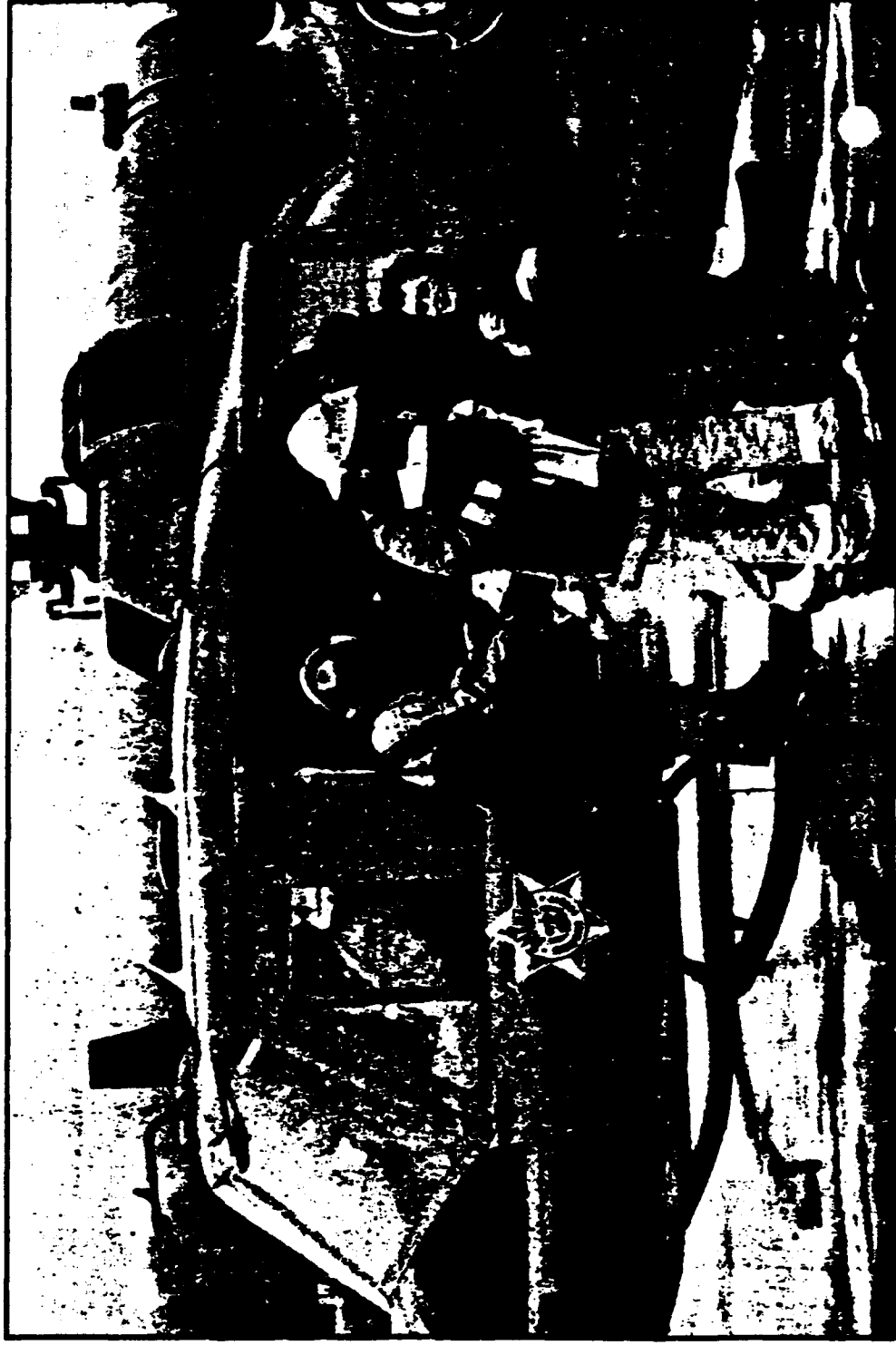
The flooding forced 75 people to evacuate their homes. Most were rescued by helicopters, some from their rooftops. State Fisheries Department boats assisted many in the Stillaguamish Valley.

Sandbagging on the east side of Ebey Island was abandoned Saturday night after the area flooded and the dikes became unusable. Workers still were stacking sandbags on the island's south end, however. The island has been completely evacuated.

Only a miracle could have saved Ebey Island from flooding overnight, said Noel Gilbrough, a sector engineer for the Army Corps of Engineers.

At midnight, an Army helicopter from Fort Lewis was still trying to rescue 10 people trapped in a mobile home in the Tulaco area south of Monroe.

"We've had boats try (but) were unable to get to it," said John Gall, spokesman for the county's emergency management department.



Flood victims are unloaded from a Snohomish County Search and Rescue helicopter at the Monroe Airport near the fairgrounds.

See FLOOD,  
back page, this section

# FLOOD

from Page 1

The National Weather Service predicted the Snohomish River would surge over dikes throughout the valley and said river flow levels would dramatically exceed all records.

The Snohomish could be flowing at 150,000 to 160,000 cubic feet per second early this morning, county emergency management officials said. If that occurs, Gilbrough said, it would be 1½ times the Columbia River's average flow at Wenatchee.

The Snohomish's record flow was 137,000 cubic feet per second on February 10, 1951.

Residents in the lower Snohomish River valley, from Monroe to Snohomish, were urged Saturday morning to evacuate.

Two homes were swept down the Skykomish River Saturday afternoon, and another home was threatened Saturday night, said Eric Andrew, chief of Snohomish County Fire District 26.

But no deaths or severe injuries had been reported in the county Saturday night.

Three diking districts near Snohomish flooded, swamping an estimated 4,000 acres, said Don Thompson, assistant flood engineer for the Army Corps of Engineers. He estimated that 20,000 sandbags had been sent to the Snohomish River basin Saturday.

In Stanwood, volunteers stacked an estimated 10,000 sandbags to fend off the raging Stillaguamish. About 30 people were evacuated from south of town.

"It looks like a replay of two weeks ago," the Corps' Gilbrough said. Federal officials are still considering a request from Gov. Booth Gardner for a federal disaster declaration for that flood damage.

The flooding earlier this month caused \$2 million in damage to county roads and bridges and damaged an estimated 180 homes, 23 of which were destroyed.

Burlington-Northern's east-west train service was first interrupted about 2:30 a.m. Saturday and traffic to and from Seattle also has been halted, an employee at the company's Everett yard said.

"Somebody should put a dollar value on misery," Gilbrough said. "You can imagine the people who for the second time in two weeks had the water at almost exactly the same elevation. Sometimes there's five feet of water in a house."

The county's emergency management officials said flood levels along the Stillaguamish at Arlington and the Skykomish River at Gold Bar Saturday exceeded previous record levels.

The level of the Snohomish River at the Highway 9 bridge gauge had virtually tied the level recorded in the massive 1975 flood, Galt said.

Jack Granstrom, who lives with his wife, Lynn, in a farmhouse near the confluence of the North and South forks of the Stillaguamish in Arlington, said, "Everybody up and down the valley, even the oldest of the old-timers, is saying this is the worst flood they can remember in these parts."

The Granstroms lost their 700-pound pig when she decided "to go swimming sometime last night," he said. At one point all of the Granstrom's 25 acres were under water, including about 10 acres of Christmas trees he was hoping to sell during this holiday season.

Roy Strotz, who runs a country feed store near Island Crossing, said water rushed several inches deep through the shop, the first time in memory floods have come as high.

Flood waters killed several down chickens and peacocks, said Strotz, assistant fire chief with Snohomish County Fire District 18. Several tons of animal feed also were destroyed.

The numbers dramatize the magnitude of the flooding:

• The Stillaguamish at Arlington crested at 19.95 feet at 7 a.m. Saturday. The previous high was 19.83 feet, in 1969.

• Skykomish River at Gold Bar crested at 22.35 feet at 7 a.m., Saturday. Previous record was 21.34 feet, in 1969.

• The Snohomish River at Highway 9 reached 30.04 feet, compared with a recorded 33.16 feet in 1975.

The Snohomish was still rising late Saturday night and was expected to hit a water volume record of 160,000 cubic feet per second at Snohomish, at about 3 a.m. today. That compares with a record of 113,000 cubic feet per second at Monroe in 1975, Galt said.

The heavy rains were blamed by weather service officials on warm, moist air from the Pacific which collided with cool air, creating a massive storm which stalled over the state.

The heaviest precipitation fell between Sequim and Stevens passes, said Bruce Remmel, National Weather Service forecaster.

In the 24 hours ending at 2 p.m. Saturday, 7.3 inches fell at Sequim Pass and 6.53 inches fell at Stevens Pass. At Spada Lake in the Sultan Basin, 7.5 inches fell during the 24 hours ending at 2 p.m. Saturday.

At Cushman Dam on Spada Lake, rising waters have spilled unchecked over the spillway since Thursday, said Sue Richardson, duty supervisor for the Snohomish County PUD.

As of about 5 p.m. Saturday, the lake's level was still 5.4 feet above the spillway, releasing 16,000 cubic feet per second into the Sultan River, Richardson said.

The Sultan joins with the Skykomish River at the town of Sultan where

there was heavy flooding Friday night and Saturday.

A major power line serving the Skykomish Valley east of Gold Bar was wiped out by a tree about dusk Saturday, the PUD's Richardson said. It was not immediately known when the line would be repaired.

Otherwise, scattered outages remained from Friday's windstorm and flood damage. However, Richardson said, it's unlikely PUD crews will be able to get to a lot of them until the water recedes.

"Once all of this is over, we have a lot of lines and wires to rebuild," she said.

Utility crews finally were able to catch up to one outage in the Darrington area Saturday, after water that had blocked Highway 530 Friday in the vicinity of Swede Haven Road receded.

Richardson said the PUD had a helicopter standing by to send a crew in, but the road cleared long enough to get in personnel and equipment by road.

The National Guard's 803rd Armored Battalion, based out of Everett and Snohomish, was mobilized Saturday morning by Gardner to help flood victims in the Skagit Valley.

Lt. Hank Thompson said 73 soldiers and 17 trucks were dispatched.

Personnel are being used to help the Skagit County Department of Emergency Services fill and transport sandbags, evacuate victims and stand guard over evacuated Fir Island, which was flooded hard for the second time this month.

Among the gear are four 10-ton ammunition haulers that were "hauling sandbags," Thompson said. "They work just fine."

Local crews, including some personnel from Port Orchard and Bremerton, may have to stay for days, Thompson said.

The same unit sent crews to Skagit County in the floods two weeks ago, and some were kept on duty for seven days, Thompson said.

There was flooding on Camano Island Saturday afternoon and two homes at the north end of the island were reported damaged by mudslides, said Rob Simon, dispatcher with the Stanwood-Camano Emergency Services.

In Sultan, there was no right side of the railroad tracks. Homes on both sides were heavily damaged as was the downtown business district. Wary of the rising waters entering their station, firefighters moved their emergency vehicles to higher ground at city hall.

By late morning, the roofs of some homes peeked above the flood waters like spears on a map. Rescue boats made their way through the murky, turbulent waters and an occasional rescue helicopter hovered overhead.

"There's going to be more homes damaged this time" compared to the flood waters of two weeks ago, said Allen Abbott, who was directing operations at the Red Cross center in Sultan. He was part of a Red Cross damage assessment team in the wake of the last flood.

The Red Cross center in Sultan sheltered seven people through the day. But Abbott figured many more were trapped in their homes and couldn't be reached or had fled early and taken refuge with friends and relatives.

But there was some good news, said Pastor Jerry Ingram, whose First Baptist Church served as the Red Cross evacuation center Saturday. "I think more people were prepared this time. Most people left early," he said.

In Monroe, U.S. Navy and Snohomish County helicopters plucked about 36 people from their homes and airlifted them to the local airport, said Fire Chief Kirk Sticks. The helicopter rescues were suspended at about 5:30 p.m. due to darkness.

"The old timers in the valley are saying there is as much water in the valley as there has ever been," Sticks said.

Also contributing to this report were Herald reporters Eric Sharick and Jim Halsey.

*Seattle P.O.*

*Nov. 25, 1990*

# Fir Island is hit by second flood in two weeks

by Kate Shatzkin  
Times staff reporter

CONWAY, Skagit County — Once again, the river beat Fir Island.

The north fork of the Skagit River prevailed over residents' efforts to hold it back yesterday, and, breaking through a temporary levee, flooded the river-delta community for the second time in two weeks.

The river gushed through the 31-foot-high closure at about 11 a.m. and just kept rising.

"The new levee they built? It's like it never existed," said Tim Bright, a member of a Navy search-and-rescue team dispatched from Whidbey Island to check homes for stranded residents.

"The water's going straight to the ocean via every farm in its way," he said.

Residents from nearly all the 190 homes on the delta were evacuated again, as were residents of the upriver towns of Lyman, Hamilton and Thunderbird.

Army Corps of Engineers spokesman David Harris said the levee break on Fir Island couldn't be repaired until the water recedes.

That isn't likely to be for some time.

The National Weather Service was predicting the Skagit River would crest at 36 feet at Mount Vernon at 10 a.m. today, and downtown Mount Vernon would likely be flooded.

So-called "jersey barriers" of concrete forms usually used to separate highway lanes were holding back the river there. The barriers strung out along the levee just matched the expected flood level — 36 feet — and couldn't be

raised with sandbags, officials said.

If those predictions hold up, officials said the flooding on Fir Island should be as bad or worse than it was two weeks ago, but they said it was impossible to tell how much water would be left on the delta when it is all over.

"It's absolutely impossible to predict how much water we're going to have on the island when this thing crests out," said Don McKeehen of the Skagit County Department of Emergency Management.

He said at least four breaks in the salt-water dike that holds back Skagit Bay could serve to drain the fresh water; on the other hand, salt water could come in through those openings.

Officials also hope the water will go down more quickly than it did in the last flood, which would reduce the damage.

Fir Islanders, many of whom had lost everything in the first flood, reacted with a mixture of numbness and resignation.

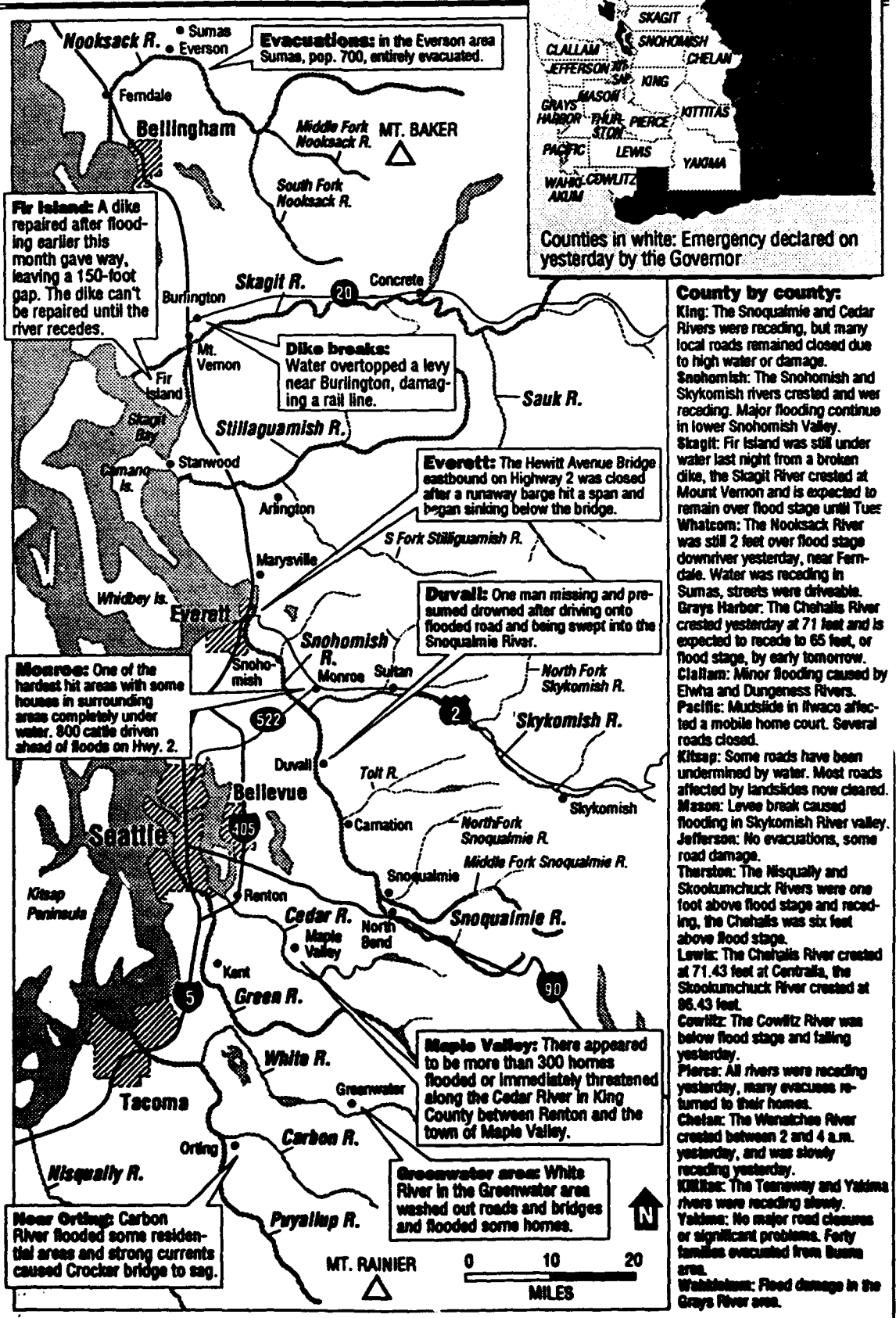
"What else could it do — carry the house away?" asked Betsy Ruble, whose Mann Road home held two feet of water during the last flood.

"I think we feel like a fighter who's been knocked to the deck and our opponent is still leaning down and punching us," McKeehen said.

Volunteers young and old concentrated on shoveling gravel into hundreds of sandbags to be trucked to the North Fork Bridge, where they were to be loaded into Army Reserve helicopters and deposited next to weakened levees near the mouth of the river.

Despite setbacks, residents were determined to keep fighting.

# Flooding at a glance



NOV 27 1990

Allen's P.C.B. Est. 1988

# Way cleared for federal aid

## President declares disaster in Skagit, two other counties

By CHARLES SIDERIUS  
Staff Writer

President Bush made official Monday what residents here have known for two weeks.

The president signed a federal disaster declaration, assuring federal assistance for Skagit, Whatcom and Snohomish counties because of flooding over the Veterans Day weekend. ■ *More flood coverage, A3-5*

The proclamation is good news to local officials like Tom Sheahan, Skagit County emergency management director, who has spent much of the month grappling with flood damage in the county.

"The outlook is a lot better. I'm looking out and seeing clear sky, and that means we're going to lose some water," Sheahan said.

The proclamation clears the way for the county to get money to repair homes, roads, dikes and other property affected by flooding.

Bush left the declaration open-ended to allow other counties to be included if assessments by the state and the Federal Emergency Management Agency find sufficient damage, said Dan Youmans, Gov. Booth Gardner's press secretary.

Gardner suggested Monday that damage statewide could be at least \$100 million for the Veterans Day and Thanksgiving Day floods. But aides said that was just a guess and the actual figure could go much higher, the *Seattle Post-Intelligencer* reported.

"We're waiting for water levels to go down enough so we can get in and truly assess what the damage has been," Youmans said. "Hopefully that will be later this week, but in some places it will be difficult to get in there."

Parts of the county have barely begun recovering from the second bout of flooding in two weeks, which forced the evacuation of more than 1,600 people and caused property damage in the millions of dollars.

Damage to public and private property in Skagit County from the flood two weeks ago is estimated at \$24.5 million.

Areas still reeling include Fir Island, Hamilton, Lyman, Cockreham Island, Swan Road near Francis Road and Nookachamps Creek basin, Sheahan said.

The priority today, he said, is to improve roads so they are usable. After that, federal disaster-relief teams will assess damage and long-term repairs can begin, he said.

On Fir Island, water from the Skagit River is still pouring through a 350-foot hole in a northern dike. Officials from the U.S. Army Corps of Engineers and Skagit County Public Works met today to decide how they will plug the hole, said Public Works Director Mark Spahr.

Officials plan to measure the depth of the area near the hole and then dump fill as they did the first time the dike broke two weeks ago, he said.

With the help of an Everett-based National Guard unit, a U.S. Army Reserve helicopter today will continue ferrying sandbags from the North Fork bridge to a weakened section of dike at the northwest corner of the island.

Elsewhere, damage to roads and smaller, isolated areas is being assessed, said Don McKeehen, county emergency services spokesman in Conway.

In the Samish River basin, waves rolled

See BUSH ISSUES, Page A11



# Bush issues disaster declaration for three counties

Continued from Page A1

across hundreds of acres of inundated fields, and water covered Farm-to-Market Road in numerous spots. A sign hanging in the window of one flooded home was an example of the attitude many people are taking.

"Johnson's Houseboat. Welcome Aboard!" the sign read.

But the basin seemed to get less water in the most recent flood than it did two weeks ago, said Mike Henery, owner of Henery's Corner Market at Allen West Road and Chuckanut Drive.

Two weeks ago, Henery's store

had 6 inches of water inside. This time, the water came 3 inches from the door, he said.

Officials planned to take air tours to assess county damage throughout the day, he said.

McKeehen, who has staffed a media center/relief station at Concrete for most of the month, said he is moving operations to the Skagit County Courthouse at noon today.

Because the situation on Fir Island remains mostly static, he said, a more centralized location will better serve other areas affected by flooding.

"We focus so much attention on Fir Island because of the drama of the break. But there are a lot of places that are just as devastated," he said.

The weather forecast should allow county and city officials to drop their emergency stance.

Rain is forecast, but cooler temperatures are predicted. For Skagit County that means an absence of warm weather, which caused mountain precipitation to fall, bloating the river.

This morning the Skagit River at Concrete was reported to be at 24.2 feet and dropping. At its highest, the river was reported to

be at 37.3 feet Sunday, according to the National Weather Service.

The height of the river at its peak is still being disputed by other observers such as the Army Corps of Engineers, who say the river crested at 35.4 feet. Officials at the Anacortes Water Treatment Plant on River Bend Road in Mount Vernon measured the crest at 35 feet.

The flood stage for the river at Concrete and Mount Vernon is 28 feet.

The weather service's gauge in Mount Vernon is not operating today and will require servicing, said a weather service spokesman.

NOV 27 1990

Allen's P. C. B. Est. 1888

# Nooksack River cuts new channel

## Course endangers businesses, homes

By CAROL FERM  
of the Herald staff

Last weekend's flooding only marginally increased property damage in most parts of Whatcom County, emergency officials said.

But in at least one area, new flood damage may have set the stage for worse things to come.

Midway between Deming and Nugent's Corner, an Army Corps of Engineers crew worked feverishly Monday night to force the Nooksack River back into its regular course.

On Monday afternoon, the river was churning northward across former fields and farmland, having eaten away its steep-sided banks and cut a new channel at the end of Mariotta Road. It returned to its old bed about a third of a mile from Nugent's Corner.

About half the river's chocolate-colored water appeared to be rushing along in the new course.

"We used to have farmland here. Now it's a brand new river," said Bob Ball, manager of the Stewart farm off Mount Baker Highway.

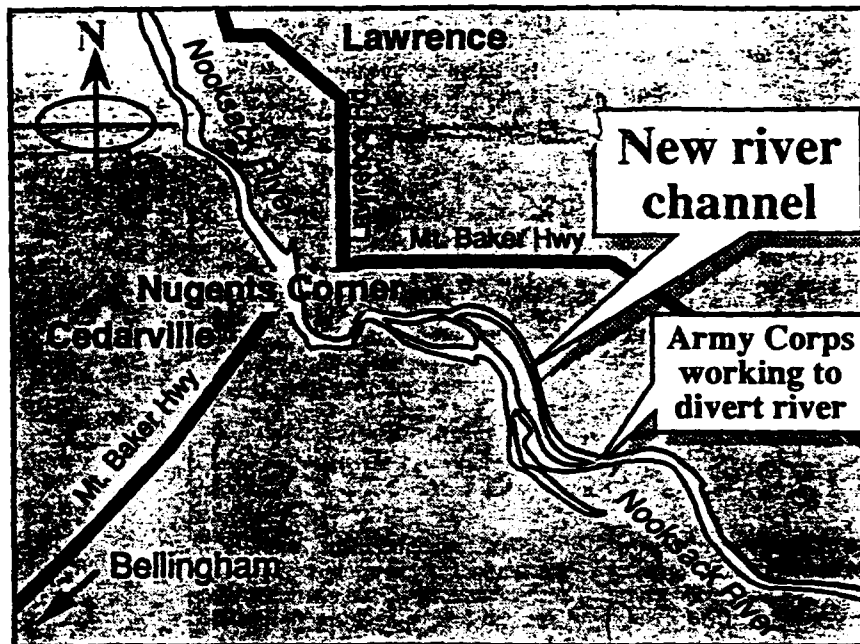
The new course is worrisome not just for farmers and property owners whose once-tranquil fields are now river sluicing across mudflats.

Emergency officials say if another flood should occur before repairs are made, the river might continue its new channel straight on — smack into Nugent's Corner.

About a dozen businesses and at least 40 residences would be endangered if that happened, said John Gillies, district conservationist with the U.S. Soil Conservation Service. Flood waters also could damage the Deming Road, Highway 9, and the Mount Baker Highway at next high water, unless the river is re-directed, he said.

"If we get into another flood situation, we could have a serious problem," said Gillies. "We're just trying to do something between

(Continued on Page A2, Col. 1)



Map shows where the flooded Nooksack River has cut a new channel.

## Nooksack cuts new channel

(Continued from Page A1)  
floods."

The Dale Lee farm, once situated on the north bank of the river, now is on an island, flanked by the Nooksack's old and new channels.

Arill Berg, engineer with the Army Corps, said he and his crews had finished extending Mariotta Road out to the new channel by early evening Monday, and would work through the night to begin returning the river to its old bed.

"The river doesn't belong in here,"

he said. "This is real prime farmland."

He said the river was able to cut the new channel because so much of the riverbank was eroded by flooding earlier this month. When water again swept down out of the mountains last weekend, there was not enough earth to contain it.

Berg said once the river is back in its old channel, the county likely will need to build a levee to prevent the same thing from happening again upstream.

At a public meeting earlier this

month in Deming, area residents urged officials to dump plans for million-dollar studies of the floodplain, and to put the money into shoring up riverbanks and dredging shallow areas.

### Where to call

Disaster aid applications will be taken by telephone starting today. The toll-free number is 1-800-462-9029.

The number will operate from 8 a.m. to 6 p.m. seven days a week until further notice. Multilingual operators are available.



Staght County and U.S. Army Corps of Engineer crews build a road next to a broken dike on the north end of Fir Island Tuesday. Working around the clock, crews finished building the 1,000-foot road leading to the dike break this morning. On the Staght River side, a 15-foot wide chunk of soil sloughed off the water-logged dike.

Scott Tennell / Staght Valley Herald

# Sizing up Great

Seattle Times  
Nov. 30

Experts agree it was big, but was it The Big One?

## Flood of '90

by Eric Pryne  
Times staff reporter

Just how big were the floods that inundated Western Washington's river valleys last weekend? Depends on how you measure them, and who you ask.

Take the Skykomish River at Gold Bar, Snohomish County. It topped 22 feet Sunday, the highest reading since record keeping began in 1928.

The National Weather Service says it was the Big One, a 100-year flood. That's a discharge that has a 1 percent chance of happening any given year, or just once in a century.

But the Army Corps of Engineers, which builds and maintains dams and dikes, calculates the flow of the Skykomish at Gold Bar was more like a 33-year flood, not the 100-year whopper.

The corps won't say the weather service is wrong. The weather service won't say the corps is wrong.

Confused? There's more.

The U.S. Geological Survey, the federal agency that maintains more than 250 flow gauges on Washington rivers, says the Skykomish at Gold Bar experienced a 50-year flood. The King County Surface Water Management Division says it was a 55-year flood.

And several of the agencies say their estimates could change.

The agencies don't disagree on how high the river got. They differ only on the likelihood of recurrence, the chance the river will reach that high again.

Describing floods in recurrence intervals — a 100-year flood, a 25-year flood — is a common point of reference for measuring and comparing them.

The concept seems relatively easy for the public to grasp, and it has been institutionalized in government regulation.

The federal government requires flood insurance for buildings in the 100-year flood plain — land likely to get wet in a 100-year flood. Counties impose additional conditions or restrict development there.

But the scientists who calculate what constitutes a 100-year flood readily admit that, despite such advances as satellite telemetry and computer modeling, there's still plenty of guesswork in what they do.

Like most hard science, it has soft spots. The uncertainties and variables can produce conflicting

results, such as those on the Skykomish.

Some scientists say that characterizing floods in recurrence-interval terms may hinder public understanding as much as it helps.

"It's a reference point that the public understands," said Bob Jackson, acting hydrologist in the Seattle office of the weather service. "But they don't understand it, either."

"It's something hydrologists got locked into doing years ago. It's what people want to hear," said Chuck Swift, acting water-resources chief in the state office of the Geological Survey in Tacoma. "I think we made a mistake doing that."

Larry Merkle, chief of hydrology and hydraulics for the Corps of Engineers' Seattle district, says he and his cohorts who calculate recurrence intervals sometimes are accused of practicing witchcraft, voodoo, throwing darts at a dartboard.

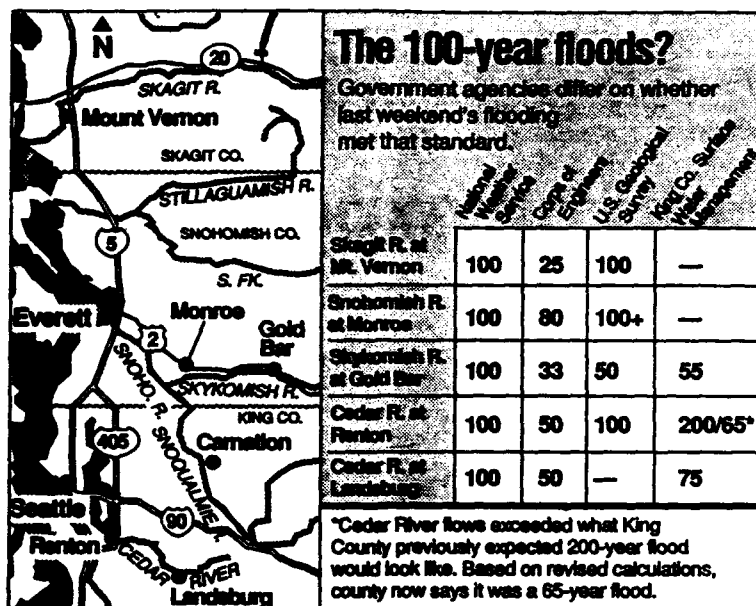
"At times it's more of an art than a science," said Dan Harvey, the corps' chief of hydraulics.

The scientists want you to understand that the recurrence interval figures they produce aren't absolute. "This is strictly statistical," said Maury Miles, a Geological Survey scientist.

If you flip a coin 10 times, statistics say it should come up heads half the time, tails half the time, on average. But that doesn't mean it's impossible for the coin to come up heads all 10 times.

By the same token, you should get a 25-year flood only once every 25 years, on average.

But that doesn't mean it's impossible to get two 25-year floods two weeks apart, as the corps of Engineers says happened on the



Ed Walker / Seattle Times

Skagit River at Mount Vernon this month.

The scientists also want you to understand that what they produce is fluid, subject to revision as circumstances change and new information becomes available.

Based on last weekend's flood, for instance, the King County Surface Water Management Division plans to change its definition of what constitutes a 100-year flood on the Cedar River at Renton.

Under the old standard, last Sunday's flood there was a 200-year event. Under the new formula, it's only a 65-year flood.

The complex calculations that produce such estimates begin with hard data: River-elevation readings recorded at the Geological Survey's gauges are beamed via satellite to Tacoma, where they are translated into cubic feet of water per second. All agencies use the survey's data.

Scientists don't have a century of readings on any Western Washington river on which to base their calculations. So they extrapolate: When 10 years of data on a stream have been collected, the Geological Survey runs the peak flows from each year through a computer program that plots the probability of flows of certain volumes. Other agencies follow similar procedures.

Before last weekend's flood, for instance, King County figured there was just a 1 percent chance in any given year of a flood on the Cedar at Renton exceeding 8,500 cubic feet per second. So 8,500 cubic feet per second was the considered the 100-year flood.

But uncertainties abound, experts admit. Gauges can stop functioning in floods, forcing scientists

to estimate.

And even if the gauges do work, they measure only the river's surface elevation — not how far the surface is from the stream bed. A flood can scour the bottom or deposits sediment there, altering flow volumes — the basis for the 100-year flood calculations.

Swift of the Geological Survey says scientists can get that information in the field. But in many instances, he said, they haven't been able to get out to the stations to find out how last weekend's floods altered stream beds. The peak flow and recurrence interval figures released this week are "a first, rough cut," he said.

Then there's the relatively brief period of record. Because the past record of flooding may be only a few decades long, "You may not know what that 1 percent chance of flooding really is," said Derek Booth, a geologist with the King County Surface Water Management Division.

A big flood can alter calculations significantly, as it has for King County on the Cedar.

And even if a century of data were available, Merkle says there's no assurance the past century is typical of all time.

Recurrence-interval figures vary among agencies because the information they plug into their calculations isn't always the same. "There are a lot of different tools," said Larry Gibbons of King County. "There are lots of variables."

For instance: Both Merkle and Swift say that comparing a flood last weekend with one on the same river at the same point 50 years ago is like comparing apples and oranges, because background conditions in the watershed that affect runoff — dams, levees, development, logging — change.

They say the Geological Survey's calculations don't account for such changes, while the corps makes more of an effort to factor them in.

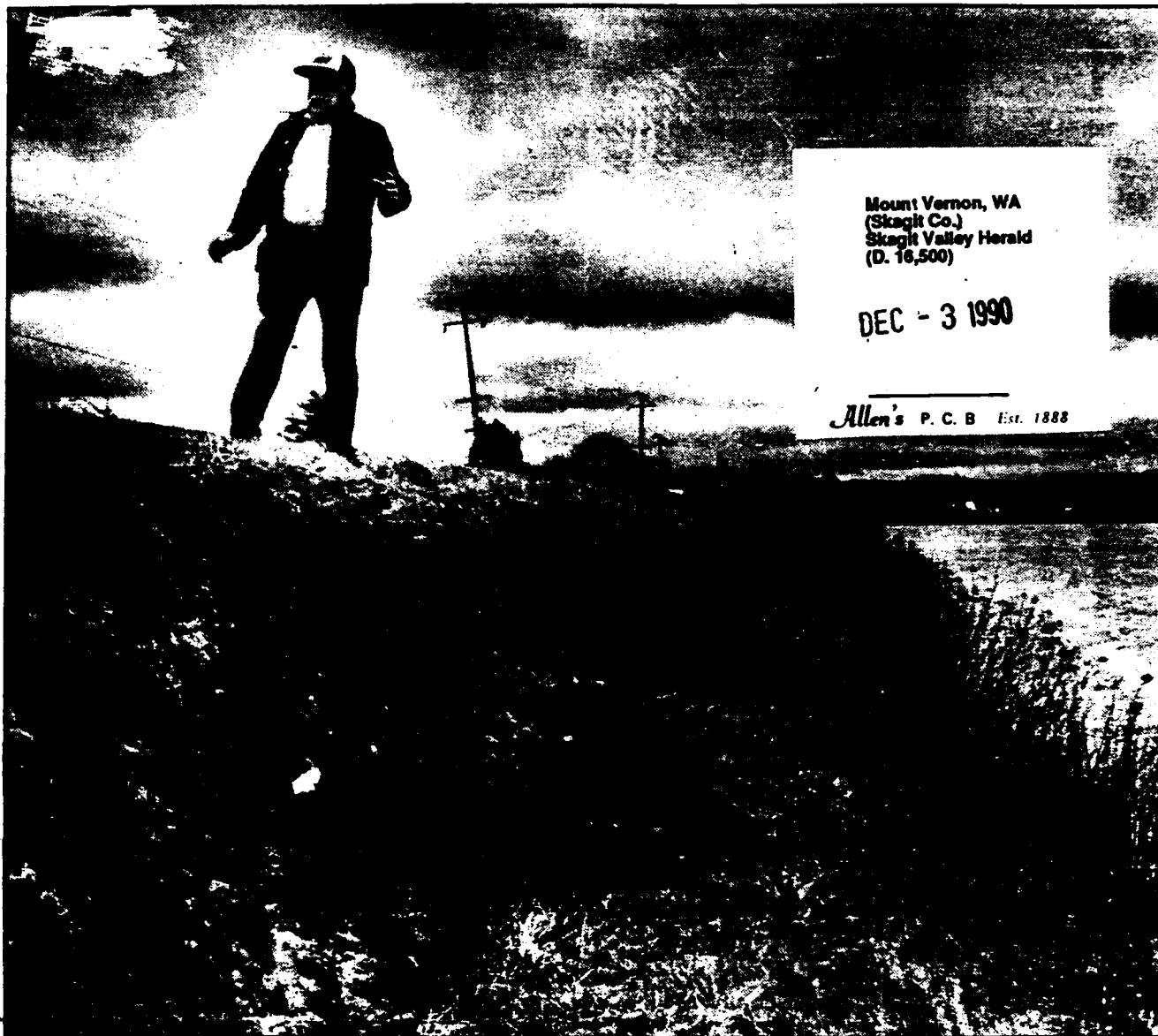
Swift said it's the direction in which hydrologists and hydraulic engineers are moving, but they still are learning how to quantify those changes and plug them into their recurrence-interval calculations.

Changing conditions in watersheds may mean the same peak flow that was calculated as a 100-year flood years ago is something likely to occur more frequently today, Swift said, but the recurrence-interval figures haven't always kept pace.

The state may be experiencing more 100-year floods because they are no longer 100-year floods. "We are getting more large floods than we did years ago," Swift said.

■ Times staff reporter Katherine Long contributed to this report.

# Keeping watch on the dikes



Mount Vernon, WA  
(Skagit Co.)  
Skagit Valley Herald  
(D. 16,500)

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Scott Terrell / Skagit Valley Herald

Matthew Paul, a Dike District 17 commissioner, stands atop a section of dike in the River Bend Road area. A 500-foot stretch of the dike is failing near where he stands.

## Floods weaken River Bend dike

By CHARLES SIDERIUS  
and M. SHARON BAKER  
Staff Writers

**MOUNT VERNON** — A 500-foot section of dike on River Bend Road is "sliding away" and won't hold if the Skagit River floods again, a dike district commissioner said today.

"There are more failures like this in other districts," said Matthew Paul, Dike District 17 commissioner. "We have a serious problem here. It's going to cost a lot of money."

Trucks have been dumping gravel and dirt near the weakened section since it was discovered Saturday morning. Crews

continued to work on the section today. A backhoe is moving fill from the street to the dike.

Standing on top of the grassy dike earlier today, Paul said nothing but dirt stands between Mount Vernon and high water if the river rises again. A crack running parallel along the dike separates whole sections of grass and dirt from the rest of the dike.

The section of dike is of concern because of its proximity to the Anacortes Water Treatment Plant, which provides water to Fidalgo Island and parts of Whidbey Island as well as La Conner.

Ed Capasso, chief operator at the

plant, is not concerned the plant will flood because the plant maintains its own section of dike.

"The portion of the river dike we own is in great shape and we also have a 3 foot high ring-dike around the plant. I think the dike district portion of the dike we're worried about," Capasso said.

"I guess our second worry is the River Bend Road (along the river dike) he said. "We need that road for people here as well as chemicals and the water."

Other dike districts are having pro

See OFFICIALS, Page 1

# Officials keep watch on saturated dike system

Continued from Page A1

lems with sloughing and erosion, although the River Bend area is of the most concern, said Dave Brookings, assistant flood control engineer for Skagit County.

"We have some crews in there working right now," he said, "We're putting Band-Aids on our wounds (all around the county)."

Paul says he can't explain why riprap, a wall of broken stones that protects the bank behind the River Bend-area dike, has disappeared.

"It is not going into the river, it is going straight down," said Paul, a dike commissioner for more than a dozen years. "This has never happened before, it is the first time."

Paul predicted that serious problems will occur if the river reaches 30 feet — about 5 feet lower than its peak last Sunday. The Skagit River at Mount Vernon was 18.7 feet at 10 a.m. today.

County officials, U.S. Army Corps of Engineers officials and dike commissioners were meeting today to decide what should be done about the weakened dike at River Bend Road.

Work also is continuing on other dikes, including those bordering water-saturated Fir Island. A temporary rock closure being built by the corps is almost done, Brookings said.

Jarr Duchnowski, a spokeswoman for the U.S. Army Corps of Engineers, said the corps expects to finish the temporary dike by 6 a.m. Tuesday.

"That's continuous work, 24 hours a day since last Wednesday," she said. "As soon as that's finished we'll jump right in and start on the permanent closure. We expect to be finished in three weeks, just before Christmas."

Duchnowski said it will cost about \$600,000 to repair the permanent dike.

"The permanent closure will be built right behind the temporary one," she said. "It will be 5 feet higher than the rock closure and rebuilt to the height of the (rest of



Stephen Schroeder/Skagit Valley Herald

Jerry Pelland (left) and Ken Smiley carry a section of 18-inch pipe in west Mount Vernon. The pipe and a pump were used to remove water from a flood-created pond next to the KBRC radio station to nearby storm drains. The pump's capacity is about 5,000 gallons per minute.

the dike)."

On the south end of the island, the county is working with the Soil Conservation Service and Dike District 22 to obtain SCS funding to repair holes in the saltwater dike.

"Hopefully we can start repairing the saltwater dikes tomorrow," Brookings said. Reportedly, there are at least nine significant breaks in the saltwater dike.

A forecast of high tides, warmer weather and rain for the next few days is not worrying county officials.

"We're in store for some really high tides this month, which is a normal occurrence," Brookings said. "Today, we start into the 13-foot tides which is just about as high as they get around here."

Meanwhile, flood-related work goes on elsewhere in the county.

One of the biggest problems now is standing water, said Brookings.

"Everything is saturated and the water is finding its lowest ground," he said. "A lot of pipes were blocked for so long, and couldn't drain."

"It is a matter of time before the low areas drain and we're trying to help them along by pumping. We still have a lot of problems and a lot of erosion."

Other areas of concern include some streams on the northern slope of the Skagit, especially near Lyman and Hamilton, that have

been filled with gravel and other debris, he said.

"It has filled those streams to capacity," Brookings said. "They don't have channels."

The uncontrolled water is causing some damage to private property, he said, and the county doesn't have any jurisdiction over the streams so it hasn't been able to go in and clean them out.

Mount Vernon's revetment, a retaining wall in the downtown area, is open for parking but is being closely watched.

"It's suffered slightly during both floods," said John Wiseman, city engineer. "Not that much from a structural standpoint, but we've seen some erosion underneath. At some point, we'd like to get some riprap added to it but it is safe for the present time."

The city is going to try to obtain federal assistance for revetment maintenance, he said.

■ *Skagit Valley Herald staff reporter Chad Hutson contributed to this report.*

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The Bellingham Herald

# Flood damage to dikes in the millions

## Nooksack system took a pounding

By ANDY NORSTADT  
of the Herald staff

November flooding caused more than \$3 million damage to Nooksack River dikes and bank protection systems, based on preliminary reviews by local and federal officials.

The damage occurred throughout the river's main channel from Deming west to Marletta and along the three forks, said Whatcom County engineer Ed Henken.

Damage estimates in some areas are still not in because high water has continued to make it difficult to get a close look at what remains of the dikes, he said.

The cost of repairing damage to pre-existing diking systems and riprap could be borne by the Army Corps of Engineers, with local governments required to pay a proportional share.

However, federal assistance may not be available for areas that need new dikes. County Executive Shirley Van Zanten said her staff is preparing complete cost breakdowns, funding options for repairs



Herald photo by Martin Waidelich

Flood pressure forced the Nooksack to spring a new channel east of Nugents Corner, and dikes will have to be built to restore the old channel.

and a list of priorities that the County Council may want to pursue.

Some of the most severe dike damage occurred along the east and west banks of the Nooksack south of Ferndale to Marletta, in the Nugents Corner area and along the several tributaries of the north fork of

done to those along the east side. Diking District 1 takes in river protection systems along the west bank.

"Boy, it's a mess out there," Henken said.

Extensive damage was done to the dike in Ferndale itself, from the Nooksack bridge south to the city line. Estimates on that damage are still coming in.

About \$300,000 damage was done to dikes just south of Lynden that almost washed out the Guide Meridian.

Flooding in the overflow area near Ever-son pushed water north into Sumas and British Columbia, Henken said.

No dikes exist in that area now. If river containment systems were placed, even more water could flow downriver and flood areas to the west, such as Ferndale, he said.

But no dikes could mean another flood north toward Sumas. "It's a really hard decision," he said.

An international study group with government representatives from British Columbia, Whatcom County, the Corps of Engineers, Soil Conservation Service and Department of Ecology will be formed to look at the options to control flooding coming from that area.

(See DIKES, Page B4, Col. 1)



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# Dikes

(Continued from Page B1)

South of Everson near Nugents Corner, flooding caused an estimated \$1.7 million damage to dikes and bank protection systems. However, because the Army Corps of Engineers didn't recognize diking in that

area as part of a continual system, the cost of repairs will be picked up by the Soil Conservation Service, Henken said.

Along the south fork of the Nooksack, between Acme and the confluence with the main river, about \$100,000 damage was done to dikes. About \$130,000 damage was also done to dikes between Everson and Nugents Corner.

Henken said about \$100,000 would have to be spent to construct new dikes along the middle fork of the Nooksack where none now exist if future problems are to be avoided.

He said the river was 150 feet away from one home in that area at the beginning of November. It's now within 34 inches, he said.

Though estimates are still being prepared, Henken said it could cost as much as \$500,000 to repair dikes along Canyon and Glacier creeks protecting the Glacier Springs and Mount Baker River subdivisions.

Flooding destroyed five homes in Glacier Spring last month, along with a section of road.

Glacier and Canyon creeks drain into the north fork of the Nooksack.

A potentially serious problem also exists near Glacier, where Glacier Creek is threatening to jump its bank and connect with Gallatin Creek above the town. If that occurred, there could be severe flooding in the resort community.

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Stephen Schroeder / Skagit Valley Herald

A truck dumps rock for a roadway to a break in Fir Island's saltwater dike near Brown's Slough about a mile south of Fir Island Road. Strider Construction Co. of Bellingham was one of three companies awarded contracts for some repair work this week. According to Steve Bentley, superintendent, crews will work 15 hours a day in an effort to have the road to break finished by this weekend. They hope to have the break completed by Christmas, he said.

# Tides hamper repair of sea dikes

By CHARLES SIDERIUS  
Staff Writer

CONWAY — Saltwater continues rushing back and forth with the tide through holes in Fir Island's southern dike, keeping residents away and hampering repairs.

Tide water is hurting progress of repairs to three of four major holes in the riddled southern dike that protects the island from Skagit Bay.

And, repairs to the fourth major hole, near Brown's Slough, cannot start because of federal wetlands regulations, a U.S. Army Corps of Engineers spokeswoman said today.

Dike District 22 representatives met with U.S. Army Corps of Engineers in Seattle this morning about the wetlands question, said Patricia Cook, corps spokeswoman.

She said the corps is trying to speed the permit process and will likely have a decision next week.

"We do have to look at it. We have to go see exactly what scope they are talking about," she said, "We can't just say yea or nay without knowing all the facts, it's the law."

Last week, the state Department of Fisheries waived some permit requirements so a 250-foot section of new dike near Brown's Slough could be built quickly. The new section will eliminate

about 2,000 feet of salmon breeding ground but will block tide water from the hole behind it.

The dike is perforated with manmade and flood-created holes. Holes were blasted into the dike to allow the flooded island basin to drain.

Other major holes will be repaired to look much the same as they did before November flooding. Because of that, no corps permits will be required for those, Cook said.

Two of three contracts for repairs to the dike and for a road to it were awarded this week. A Bellingham contractor is working on a new section of dike to close a hole near Brown's Slough.

"We will get the job done in 30 days barring natural disaster or significant changes in the scope of the work," said Jay VanWingerde, general manager of Strider Construction Co. "I'd like to get it done in two weeks."

Many Fir Island farmers remain away from their homes and property because of high tides. When the tide comes up, salt water floods farmers' property.

"It's going to be quite a long time before many of them move back," said Dick Mathews, who recently retired as the Washington State University Cooperative Extension dairy specialist for Skagit, Island and Snohomish counties.

Mathews visited the island and several dairy farmers recently to determine the extent of the damage.

"They've been out a month now," he said. "And it may be at least 10 days before the levees on the south side are fixed."

Farmers say much of the salt water saturated land will be extensively damaged. To be usable again, the soil will require fresh water cleaning by rain or irrigation.

"There's a tremendous amount of soil damage," he added.

In other developments:

■ Residents of Willow Lane and Riverside Drive area in Mount Vernon met Monday to further discuss flooding in their neighborhood. A private civil engineer, hired to find out if the city caused the flooding, was expected to report to the group today, said a spokesman for the neighborhood. The group has said they will file a lawsuit against the city if the report shows flooding was caused by the municipality.

■ Red Cross workers are moving from Hamilton City Hall to Mount Vernon as the case load diminishes. The Mount Vernon Red Cross center is located at Immaculate Conception Church, 215 N. 15th St.

■ Skagit Valley Herald reporter M. Sharon Baker contributed to this report.

# Failed proposal to raise levees still debated

1979 plan may have prevented flood damage, engineer says

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Scott Terrell / Skagit Valley Herald

Water laps against sandbags south of Highway 20 between Burlington and Sedro-Woolley during the second November flood. Skagit County voters in 1979 had a chance to help pay for levee improve-

ments that probably would have stopped the worst of the flooding, engineers say.

By CHARLES SIDERIUS  
Staff Writer

In the summer of 1979, thousands of people gathered in the nation's capital to rally against nuclear power.

A few hundred miles to the north, Pennsylvania's Three Mile Island nuclear power plant was still bubbling from a nuclear accident. Nationwide, the public opinion of nuclear power was nearing a meltdown.

In the fall of that year, Skagit County voters went to the polls and resoundingly said they wanted nothing to do with a nuclear power plant proposed for Bacus Hill near Sedro-Woolley.

Those same voters turned down a proposal for a county transit system, for a new county jail and for a \$55 million flood control project.

Some say the nuclear power issue caused voters to nuke a project that would have kept the Skagit River in check during November's relatively unremarkable flooding.

"I don't think there is any doubt it would have withstood this flood event," said Lester Soule, who worked on the project as a hydraulics engineer with the U.S. Army Corps of Engineers.

Others disagree, saying that while the nuclear power issue may have helped pull down the flood control project, voters were smart enough to trounce flood control because it was a quick fix solution to a long-term problem.

"Yes, it would have stopped this last flood, but with respect to the future, no, it was not a mistake (to vote it down)," said Larry Kunzler of Sedro-Woolley, who campaigned against the project.

"It was large and grandiose and it scared people," said Don Nelson, a Skagit County Flood Control engineer for at least 15 years.

The shelved U.S. Army Corps



## TAMING the wild RIVER

of Engineers' project would have raised and strengthened 34 miles of existing levees around Mount Vernon. It would have provided the entire levee system south of the Burlington-Sedro-Woolley area with a minimum river water capacity of 120,000 cubic feet per second.

The Skagit River ran at 155,000 cfs during the second November flood, Nelson estimates. The project would have protected 14,200 acres of farm land from flooding and would have slightly improved protection of a few areas in the lower valley.

The federal government and the state would have paid the bulk of the project or about \$44 million in 1979 dollars. In today's dollars, the state and federal share amounts to more than \$156 million.

Skagit County voters were being asked to pay up to \$14 million in local matching funds. In 1990 dollars, the project amount is roughly equivalent to \$50 million.

The damage last month to Fir Island alone, where a section of

dike near the North Fork twice failed, was estimated at \$5.5 million even before the second flood came. No damage estimates are available for the second flood.

Downstream from Sedro-Woolley, the project would have provided 100-year flood protection for urban areas and 50-year protection for rural areas. Mount Vernon would have gotten protection for up to a 500-year flood event. November floods were 20-25 year events, according to the corps.

Burlington and Fir Island would have both been well protected and certainly would have stayed dry this November had the project been completed, engineers say.

"I don't think anybody predicted a back-to-back flood event. You design for one though," said engineer Soule, who is now chief of the civil management section with the corps.

"It would have held for both flood events. There would have been minor scouring. I don't think any of the levees would

have failed," he said.

Upriver from Sedro-Woolley, the Nookachamps and Clear Lake areas were also to be protected by improved levees.

"We were going to utilize as much as possible of the existing levees, improving them where possible and raising them where necessary," said Soule.

Kunzler, who is in the process of writing a book about Skagit Valley flooding, said levees provide people with a false sense of security. He said the only long-term answer is to give the river a place to go.

A combination of levee improvements and construction of

the often-talked about Avon bypass is the solution, he said.

"All you do by raising the dikes is tell people in the valley who are going to be here in 100-150 years that you didn't care about solving the problem," Kunzler said.

The Avon bypass would divert a portion of floodwaters between Burlington and Mount Vernon and direct it to Padilla Bay. The bypass would thus lessen the amount of water flowing downstream in the Skagit River.

Project opponents also said the project's failings clearly out-

See DEBATE, Page 44

Continued from Page A3

weighed benefits.

There was a fear that new and stronger dikes would have backed the river up, causing more flooding in the Nookachamps, Samish basin and Clear Lake areas.

"No provisions have been made to remove Skagit River flood waters from 15,000 acres on the Samish River flats," said a newspaper advertisement opposing the project.

After voters turned the project down, Skagit County Commissioners sent the corps a letter saying local backing did not materialize. That effectively tabled the project but did not kill it because congressional authorization had already been obtained.

Congressional authorization, which does not guarantee funding, is good for 10 years once it's granted. After that, extensions of authorization can be approved.

Mount Vernon Mayor Ray Reep requested such an extension in 1988 and appears to have gotten it. Money to update the study has been requested for the next biennium, according to the corps.

"I supported the levee project. I approved of what they were trying to do at the time," said county engineer Nelson. "But this soon after, I'm afraid it would fail — not from a flood control point of view but from a social and political view. I'd be nervous about rejuvenating it."



Stephen Schroeder / Skagit Valley Herald

Hundreds of volunteers like these who helped fill sandbags in downtown Mount Vernon might have been able to stay home if a levy improvement project had been approved by voters in 1979. Engineers say it is unlikely Mount Vernon would have flooded if the flood control project had been built.

# Flooding brings years of mistakes to the surface

Some of the costly disaster was avoidable

By Angelo Bruscas  
P-I Reporter

Too much development in the wrong places, the clearcut logging of hillsides and generations of planning mistakes combined to make November's flooding one of the most costly disasters in state history.

Nature gets part of the blame — for dumping late fall snow in the Cascade foothills, followed by rapid warming and a torrent of rain.

But flood experts say last month's widespread flood damage in 19 counties — with \$100 million in private property losses and another \$100 million in damage to roads and public facilities — was not caused simply by rain and melting snow.

Some of it was avoidable. Flooding has been made much worse by years of inattention to floodway management, inability to curb development along the river valleys, and the accelerated logging of watersheds, according to more than a dozen experts interviewed by the Post-Intelligencer during the three weeks since the record floods hit.

All parties who use the rivers are partly to blame for the chronic flood damage, experts said. And lessons from past floods went ignored.

The recent frigid weather — and the next arctic blast that's about to hit — gives the region a

## Inside

- **Finding cures:** The solutions to flood problems may be expensive. **Page A4**
- **Watershed debate:** The role of timber cutting is far from certain. **Page A5**
- **Higher ground:** Residents of waterlogged town look for safer homes. **Page A5**

reprieve from swollen rivers, but experts say another wet and warm "Pineapple Express" front could bring more floods this winter and spring.

Floods are, in fact, inevitable in this climate, advocates of tougher development controls say.

"If we're expecting big floods, why do we need homes and businesses spread evenly throughout the flood plains?" asked Robert Naiman, director of the University of Washington Center for Streamside Studies. "In certain areas, we should allow the flood from year to year to act as natural storage area or to release some of the energy coming down river."

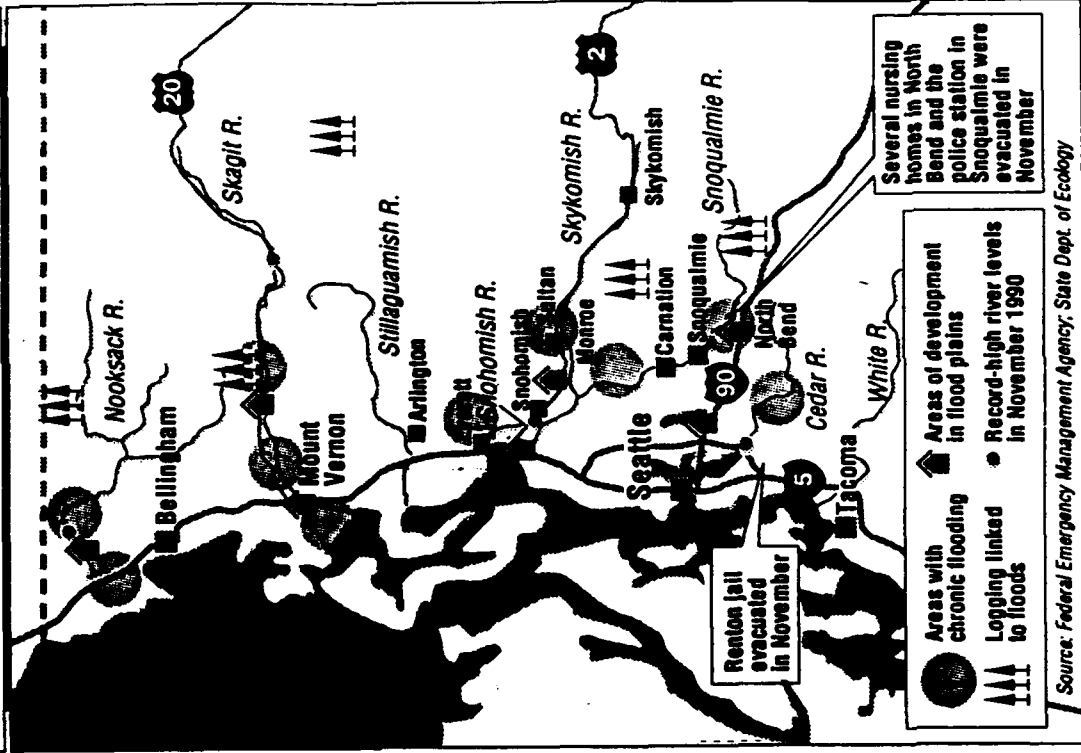
Most flood plain maps are out of date and fail to account for new growth, experts say, while coordinated efforts at flood planning have been slow in developing. Such maps, charting the high-

See **FLOODS**, Page A4

Seattle PI Dec. 27 '90

## Floods: The human factor

Civilization, in the form of logging, houses and inadequate diking, contributes to the damage — and cost to taxpayers — from Western Washington's frequent floods. Many experts say policies need to change to work with, rather than against, nature.



Source: Federal Emergency Management Agency; State Dept. of Ecology

# Floods: Levee systems give

From Page 1

water marks during floods, tell planners what areas need to be excluded from future development.

King County, for example, is just now preparing a draft of a new flood plain map. The last map was drawn in 1964.

"We had high-water record marks on the Skykomish River where there was no flood mapping to date," said Tom Bean, senior engineer for King County's Surface Water Management Department.

Also, millions of dollars in federal aid for projects that could have helped solve the problems were never spent.

Max McYoung, an avid Skagit River fisherman, noted that the U.S. Forest Service never used \$11 million authorized by Congress in the early 1980s for acquiring lands to protect the Skagit River under the federal Wild and Scenic Rivers Act. That money, McYoung says, could have been used to buy land in the river's watershed to protect it from logging, fishing or flooding damage.

The Forest Service, in letters to U.S. Rep. Al Swift, D-Wash., said the money wasn't ever requested or appropriated, but that "acquisition will occupy increasing attention in 1991."

McYoung says local government also is to blame. The Skagit County Commission, which was supporting the construction of two nuclear power plants at Sedro-Woolley in the late 1970s, was opposed to the Wild and Scenic Rivers designation for the Skagit, he said.

At the urging of power plant opponents, the Skagit River was given wild and scenic status in 1978. The nuclear plants were never built.

Across Western Washington, a major dilemma is how to hold back the natural force of rivers with decades-old dikes and levees that are designed to fail and permit flooding.

"The levee systems have given people a false sense of security," Bean said. "I look all over and see the levees are built right on top of the rivers. But you have to give the river room to move."

Bean and a team of about two dozen local, state and federal officials have been assessing damage from last month's flooding in an attempt to lessen damage in future disasters. A draft report compiled last week suggests that flooding cannot be curtailed unless development and industry are controlled.

**THE WEATHER**, on the other hand, is impossible to control.

"The way this year has gone weather-wise, anything is possible," Hank Treick, National Weather Service specialist said yesterday. "Right now there is no melting going on other than in Seattle and the lowlands. It's still colder than the dickens. But the possibility for more flooding would be great if we had another Pineapple Express come in on us."

The storm that caused November's flooding, the new damage report says, was not all that unusual.

"Precipitation amounts in the northern Western Washington watersheds were not sufficient to cause flooding under normal circumstances," it says.

How, then, did the recent flooding become the worst in state history?

Development in flood plains has increased, it says, worsening chronic flooding.

The Issaquah area and Maple Valley have developed rapidly without adequate flood control

## 'Disastrous' floods

Presidential disaster declarations for floods since 1971 in Washington state:

| Date           | Number of counties |
|----------------|--------------------|
| Feb. 9, 1971   | 7                  |
| Feb. 1, 1972   | 9                  |
| March 24, 1972 | 3                  |
| June 10, 1972  | 3                  |
| Jan. 25, 1974  | 13                 |
| Dec. 13, 1975  | 12                 |
| Dec. 10, 1977  | 18                 |
| March 12, 1979 | 1                  |
| Dec. 31, 1979  | 9                  |
| Jan. 27, 1983  | 1                  |
| Feb. 15, 1986  | 3                  |
| March 19, 1986 | 1                  |
| July 26, 1986  | 1                  |
| Dec. 15, 1986  | 7                  |
| April 14, 1989 | 4                  |
| Jan. 18, 1990  | 7                  |
| Nov. 26, 1990  | 19                 |

DAVE GRAY/P-I

and little regard for potential flood danger, Bean said.

One of the most critical problems caused by development has been flooding of public buildings, such as nursing homes, schools, police and fire departments and jails. A rescuer was killed during the evacuation of a nursing home during a 1986 flood in Sultan.

Last month's flooding caused the evacuation of several nursing homes in North Bend, and of the police station in Snoqualmie and the jail in Renton.

The team recommends that public buildings be banned in flood-prone areas.

The report notes that while



# people 'a false sense of security'

only two deaths resulted from last month's flooding, "damage to farms, homes, roads, bridges and utilities was severe and extensive." More than 500 head of cattle perished. The rising floodwater forced the evacuation of hundreds of people.

"For many of the evacuees, abandonment of their dwellings and possessions was a repeat experience," the report says. Flood investigators said many of the evacuees should not have been allowed to remain on their property after the last flood.

**BECAUSE OF PAST** mistakes in river management, some flood experts do not offer much hope that flooding damage can be avoided in the future.

"Watershed management, which cuts across numerous interests and regions, is going to require the same scale of coordination as a great disaster or war," said the UW's Naiman.

But he cautioned that there should not be a rush to create new groups and new goals "when previous goals have yet to be fully implemented."

One of the biggest obstacles to reaching those goals is the patchwork of diking districts, which farmers form to maintain the dikes and levees that try to hold the rivers to their course. The districts must struggle every year to shore up river containment systems with inadequate money and little coordination.

Snohomish County diking districts, for example, only recently agreed on a plan to allow for flooding over their dikes in certain parts of the county to ease the damage in other, more populated sections.

"After years of dueling in the sun we have finally come to agreement on river levels," said Bob Johnson, a Snohomish River diking district commissioner.

In Skagit County, Mark Watkinson of the Department of Emergency Management said current practice is to maintain or reconstruct dikes and levees to withstand a 50-year flood level.

"But those levees (that flooded on the Skagit River) are not up to those levels right now," he said.

Skagit County residents have shown a reluctance to tax themselves for flood country projects, said Lloyd Ivey, a longtime Skagit diking district commissioner.

The Army Corps of Engineers has said all dikes and levees along the Skagit should be reinforced. The corps helped initiate a countywide ballot issue in the early 1980s so residents could vote to approve the matching money needed to do the repairs.

In annual inspections this summer, the corps said the Skagit dikes and levees were well maintained, but corps officials noted that doesn't mean the system is adequate for major flood control.

"They were not designed for the level of flooding that we have had," said a corps report.

The failure of local flood control planning in Skagit County and other counties may force the Federal Emergency Management Agency to move some communities, such as Hamilton on the Skagit River and Ebey Island on the Snohomish River.

Pockets of development on the Snoqualmie and Cedar rivers may also need to be removed.

"There are six pockets from Whatcom to King County (where) we see flood after flood," said Carl Cook, natural hazards chief for the Northwest region of the Federal Emergency Management Agency.

The agency's Bob Freitag said it tried to move some residents on Ebey Island after major

flooding in the late 1970s.

"But everyone I talked to didn't want to go," he said. "The issue is people building and remaining in dangerous places. Ebey Island is a microcosm of the whole problem."

**EVERY YEAR** when communities like Ebey Island flood, taxpayers help bail out residents through the federal emergency agency.

Because of the recent floods, officials seem more determined to talk about relocation. The state now has laws that prevent reconstruction of severely damaged structures in flood plains.

Jerry Louthain, flood plain supervisor for the state Department of Ecology, sent a letter last week to local officials intended to reinforce "the provisions in the state law."

State and local officials have been too lenient after past floods, the letter says, allowing residents to improve their buildings to better withstand flooding, rather than demanding that they move.

The federal agency's Cook noted that the state got \$1 million to move people living near Mount St. Helens in 1980. But now there is only \$4 million available every year for the emergency agency's nationwide disaster relocation efforts.

Larry Anderson of the Snohomish County Planning Department said efforts to pay for the damage or to move the property owners have created a "regulatory nightmare," with sometimes conflicting federal, state and local regulations.

"If we had taken the very hard-line approach and enforced all the restrictive provisions in the various codes, we would have had to displace all these people," he said. "In reality, that was politically unacceptable."

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Bellingham Herald  
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# Taming the Nooksack: Flooding takes its course

## Engineers consider gravel removal, dredging, dikes

By ANDY NORSTADT  
of the Herald staff

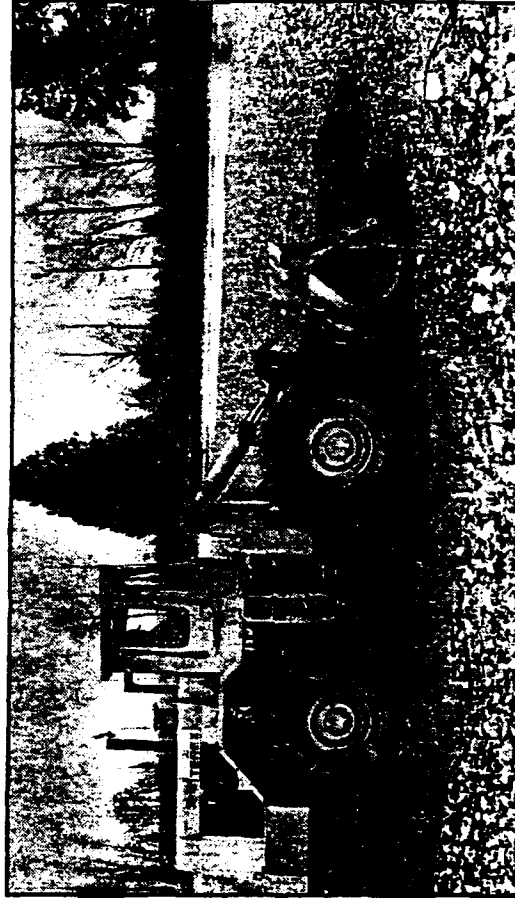
Moving ahead with flood control on the Nooksack River may mean taking a step back.

In particular, it may mean mining gravel from river bars, work done regularly by several private companies until about a decade ago.

Officials view gravel extraction as the one of quickest, simplest and cheapest method of flood control available. It's not the only answer, they said, but it is a good one.

"My gut feeling is if we could get the river back to where it was in 1975, we'd be

(See TAMING, Page A6, Col. 1)



Herald photo by Melissa Stevenson

A Cowden Gravel & Ready Mix employee "scalps" gravel from a Nooksack River bar just south of the Nugents Corner bridge. Several companies may soon start extracting rock from the river, which would help flood control efforts.

# Taming the wild Nooksack: Dredging, dikes

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in equilibrium again," said Whatcom County Engineer Ed Henken. "I would be the last one to say gravel scalping is the end-all. But it could be a significant factor."

Until a decade ago, a half dozen or more sand and gravel companies regularly worked the river bars, taking the top layer of gravel deposited with high waters each winter and spring.

Companies paid the state for the cubic yards of gravel they removed. In the process, channels were cleared, creating more room for water when the river rose.

But, as the state's charge increased, companies looked to inland gravel pits to meet their needs. With no one scooping up river gravel, the bars expanded, the channel filled and the river topped its banks with flows that two decades ago wouldn't have caused half as many problems, an engineer said.

Other flood-control measures could involve substantial amounts of time, study and money, with no guarantee of funding. Projects being considered include new levees and river dredging at Marietta.

The goal of gravel extraction is to balance again the amount of material added to the channel with the amount removed, Henken said.

A change in focus by the state Department of Natural Resources staff may mean that goal is at least partly attainable.

The department manages gravel extraction as a state resource in the same way it handles sale of timber on state lands. For the last several years, Cowden Gravel and Ready Mix was the only company regularly

working the bars, taking on average about 100,000 to 120,000 cubic yards a year of material from a site just downstream from the Nugents Corner Bridge.

Ludtke-Pacific Trucking Inc. recently applied for permits to work 16 bars along the river between Flynn Road and the Everson-Goshen Road, said Cheryl Beck, coordinator of the minerals program in the Department of Natural Resources' Aquatics Division.

Two other companies also have submitted applications.

Both county officials and gravel company operators credit Beck with getting the gravel extraction program moving again.

The state allows as much gravel to be taken from a river as is replenished each year. Even with the new contracts, Beck said, "We're not even close to that on Nooksack."

Beck estimates that between 250,000 to 300,000 cubic yards of gravel could be removed from the river once work begins.

Ludtke-Pacific owner Lloyd Ludtke figures much more could be extracted.

"A million yards a year isn't beyond comprehension," he said. "I see this river as a means of supplying any amount of gravel in this area for as long as we actively want to get in and mine it. It's just mind-boggling the amount of material out there."

Officials from the federal agency most closely connected with flood control also support gravel extraction, particularly when compared with the costs and complications involved in dredging.

"That kind of process (bar scalping) is probably the best way to keep the river down," said Noel Gilbrough, study manager with the Army Corps of Engineers' office in Seattle.

The Corps can provide money to repair existing dikes. But finding money for new flood-control work is much more involved and less guaranteed.

Whatcom County last September asked the Corps to consider two proposals under its Small Flood Control Projects program. One is to construct a new levee just south of Everson to control the Nooksack's flooding into Sumas, and the other is to dredge the river's mouth.

The Corps allocated \$20,000 to do an initial "reconnaissance" study on the two projects to determine whether a more complete review is warranted.

It can take up to four years to finish the studies and get construction under way, Gilbrough said.

"Small" projects can cost no more than \$5 million. Gilbrough said funding for studies and projects must be renewed each year by Congress. Given current budget deficits and demands to trim spending, there is no assurance the money will be there, he said.

A more comprehensive basin-wide study by the Corps could pave the way for major projects ranging from extensive new levee systems to upstream dam construction or property buyouts, Gilbrough said. But it would take 10 years to complete, he said.

Without such studies, the Corps can provide short-term support and technical advice, but not on a continuing basis.

"The Corps of Engineers is not going to be out on the river next year dredging gravel. It's just not going to happen," Gilbrough said.

With the exception of work on the Toutle and Cowlitz rivers after Mount St. Helens erupted, dredging is not used as a flood-control method on any Western Washington river.

But dredging could "pull the plug" of sediment that has built up at the mouth of the river near Marietta, Gilbrough said.

He estimated the costs could run as high as \$10 a cubic yard for dredging thousands upon thousands of yards of sediment from the river. And repeated dredging probably would be needed as the sediment again builds.

"We haven't found it (dredging) to be the answer on any of the projects" handled by the Corps in Western Washington, Gilbrough said.

But building new levees can be just as expensive.

Estimating the cost of a new levee depends on conditions and type of flood control need, said Mark Hassebrook, a diking specialist with the county Engineering Division.

As an example, he said, a linear foot of dike 5 feet high and 10 feet wide at the top would take about 5 cubic yards of material to build.

The diking material can cost anywhere from \$5 to \$50 a cubic yard and that figure doesn't include the price of engineering or planning, he said.

At \$10 a yard, for example, a foot of levee would cost \$50. Multiply that by hundreds of feet needed to take a dike from high point to high point along the river bank and costs quickly skyrocket.

# You can't put a fence around a river'

By ANDY NORSTADT  
of the Herald staff

Rivers do more than just flow. They race and wander and slow to a crawl. They jump banks, erode shores, change courses and carve new channels. They dump rocks and gravel and logs in ever-shifting patterns. And they flood.

Rivers such as the Nooksack are particularly active, flowing from the steep slopes of the Cascades to the flat lands adjoining Puget Sound. Because they pass through a geologically young area, they can carry a lot of gravel and, during the rainy months of winter and spring, a lot of water.

Scientists and engineers who study waterways recognize a river's natural tendency to meander. They also note efforts by man to try to establish a permanent course for a

river and keep it there.

"We think we've done a wonderful thing by taming the rivers. But it's just a time bomb ticking," said Wolf Bauer, a Seattle engineer and river resource consultant. "You can't put a fence around a river and say, 'This is the river.'"

"We're fighting like hell to get the river to go where it doesn't want to go," added Noel Gilbrough, study manager with the Army Corps of Engineers.

Rivers should be viewed as a whole, Bauer said, with an understanding of how flood-control systems interact and affect other aspects of the channel.

For example, he pointed to dredging. Rivers don't like holes and they tend to even out the high and low spots.

Dredge one area to reduce the chance of flooding and erosion could

be increased at another spot upstream, undermining other property, Bauer said.

People also tend to ignore a river's natural patterns, particularly when it comes to building structures nearby.

Bauer pointed to the Mount Baker Highway bridge over Boulder Creek as a prime example.

The bridge was built at a spot where the creek goes from a steeper slope to flatter land before entering the Nooksack. As a result, gravel and debris carried by the stream drops out there, filling the channel. During flooding, water and gravel cover the bridge.

And for that reason, Bauer said, the bridge should have been built upstream.

Historical perspective also seems to get lost.

Bauer said a stream tends to flow throughout its "streamway," a substantially larger area than its obvious channel. A river will change routes throughout that streamway. Though the river may flow 100 feet away, behind a stand of alder, it won't necessarily stay there, he said.

"The Nooksack River has historically swung from one toe of the mountains to the other toe in the Deming area," said Mark Schuller, a state Department of Fisheries regional habitat manager. "But now, if it moves 2 feet, it causes a major disaster and people want to control it."

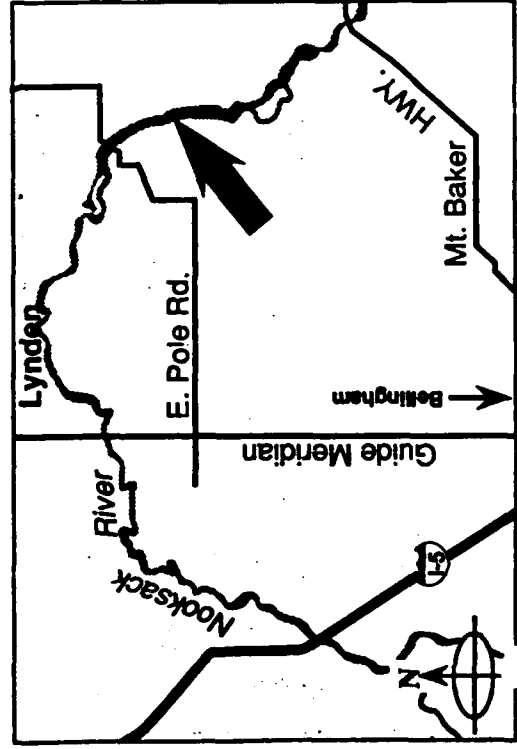
Added Bauer, "Rivers want to meander but we straitjacket them."

Planners should consider rebuilding natural river systems that strike a balance with flood-protection systems, Sedell said. Areas should be planned for backflows, floodplains and groves of hardwood forests that can slow the flow of flood waters.

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S. 25,300)

JAN 27 1991

Allen's P. C. B. Est. 1888



Map locates area shown in photos.  
Herald map by Allen Peterson

FEB 10 1991

Allen's P. C. B. Est. 1888

## Should you build on a flood plain? Opinions vary

**S**hould you build or live on a flood plain? If ever there was a winter that forces the question it's this one, with its major-league storms and floods.

The short answer is, you can build in a flood plain and be assured of federal insurance if the community has participated in establishing and administering specific flood-code regulations. These regulations typically come from the Army Corps of Engineers and local planners.

Mason and Garfield counties have no flood plain ordinances and therefore do not qualify for the National Flood Insurance Program. (Garfield has no designated flood plains, so there is no need for an ordinance.) Counties not only have to adopt an ordinance, but they also have to continually enforce it by making sure contractors build to local specifications.

Some homeowners in Mason County have received disaster relief because they were flooded, even though their homes were not in a designated flood plain. But most homeowners in Mason County flood plains would not receive disaster relief because the county has not adopted and enforced a flood plain ordinance.

Few private insurance companies, if any, will write homeowners insurance in a flood plain. The process is complicated and expen-



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sive. Some companies started but ceased when claims ran too high.

Opinions vary greatly on the advisability of building in a flood hazard area. Often, property values are greater than the cost of building levees, so construction of specific projects has been considered justifiable.

"I think we should look into not building on a flood plain at all,"

Please see **KELLY** on G 5

says Leland Jones, a soils specialist in the Seattle geo-technical firm of Shannon & Wilson. "In many cases, you are only staving off problems by building levees and rip-rap. If we built the homes on higher ground, and left the farms on the lower elevations, like in the Orient, the river could flood when it wants to and the losses would be minimal."

If you live in an area that participates in and builds at certain elevations, you cannot be denied federal flood insurance, according to Terry Tyson, president of U.S. Flood Research and Insurance, a Lynnwood-based company that specializes in flood insurance and interprets flood maps for lenders.

"Banks do have the option of requiring flood insurance over and above the federal requirement," Tyson said. "Most lenders will demand a flood determination before lending money for a home in a flood plain."

Flood-insurance costs vary with the site and scope of a project.

According to Tyson, if you are building a \$140,000 home one foot above a determined flood area, the premium would cost about \$181 a year for \$140,000 coverage on the structure. Contents are not included. The higher you build above the flood area, the less expensive the premium.

"About one-third the homes that flood are not in a special flood hazard area," Tyson said. "Flood determination is not an exact science. If it were, we'd have far fewer problems. People who own homes have to use common sense when siting their house."

A special flood hazard area is defined as a specific area that stands a 1 percent chance of flooding in any given year. Over a 30-year period, the life of most fixed-rate mortgages, there is a very good chance the area will flood. Terms like a "100-year flood" or a "30-year flood" are floods that occur every 100 or 30 years.

**The Skagit River delta,** where some of the state's most devastating flooding occurred, is more complex because the entire

area is a flood plain. However, a series of man-made levees virtually ensures that the whole delta can't be flooded at one time. A break in one levee relieves pressure on other levees. The November flood that caused the levee to break at Fir Island was a 30-year flood, according to Chuck Steele, chief of the natural and technological hazards division of the Federal Emergency Management Agency.

"Some people say that the amenities of living by a river are far greater than the problems caused by flood every 10 years," Steele said. "But I think that

attitude is changing, especially since the mid-1970s. There are more and more people who do really want to get out."

Statistics seem to provide reason for the moves toward higher ground. In the past 20 years, presidents have declared 17 flood disasters in this state, while Oregon and Idaho have had only two apiece.

■ Tom Kelly is a private real-estate consultant. His column runs every Sunday in the Home/Real Estate section of The Times. Send questions and comments to Tom Kelly's Column, P.O. Box 70, Seattle, WA, 98111.